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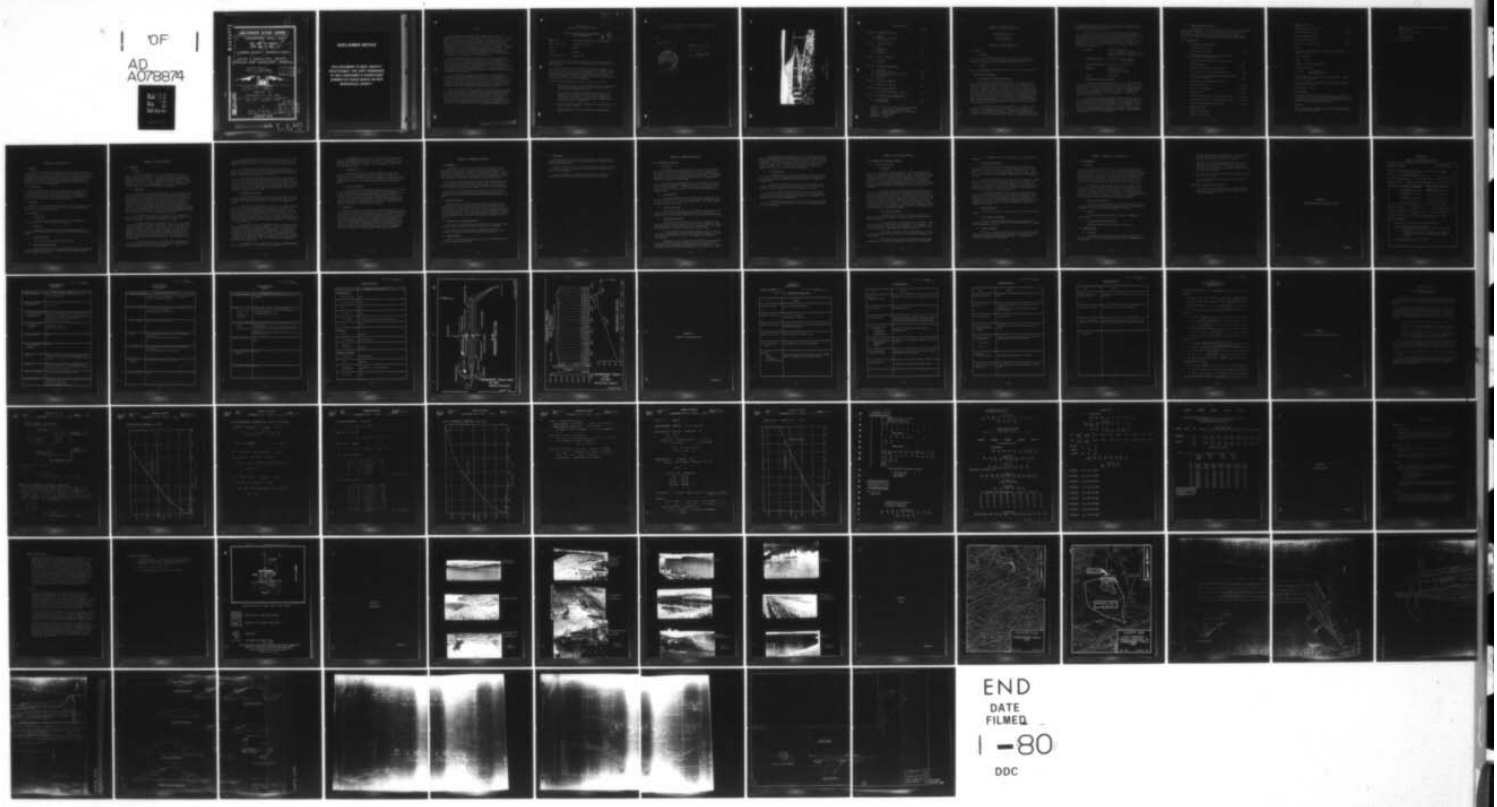

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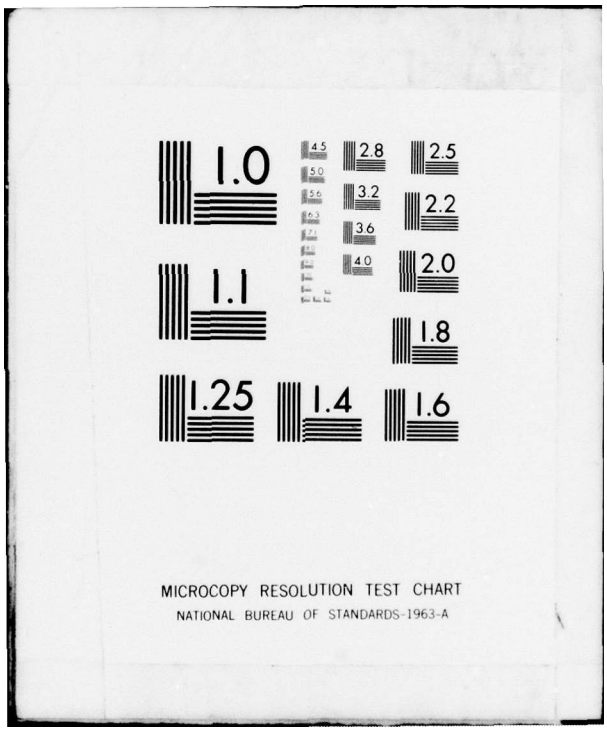
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DELAWARE RIVER BASIN

(6) National Dam Inspection Program

TOWAMENSING TRAILS DAM

NDI Number PA-00920
DER Number 13-108

CARBON COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LEVEL II

(11) Aug 79 (12) 77

PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

AUGUST 1979

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PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

Name of Dam: TOWAMENSING TRAILS DAM, NDI NO. PA-00920

State & State No: PENNSYLVANIA, 13-108

County: CARBON

Stream: WOLF RUN

Date of Inspection: June 19, 1979

Based upon the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in good condition.

In accordance with the Corps of Engineers' evaluation guidelines, the size classification of this dam is intermediate and the hazard classification is high. The spillway capacity is inadequate to pass the PMF (Probable Maximum Flood) peak inflow without overtopping the dam. The project is capable of passing 84 percent of the PMF and is considered to be inadequate, but not seriously inadequate.

The following recommendations are made for action by the owner:

1. That the erosion scars on the downstream slope be repaired and that steps be taken to improve the slope cover to protect against future erosion of the slope.

2. That the seepage condition downstream from the toe of the embankment be monitored on a regular basis noting and recording volume and clarity. If increase in volume or any turbidity is observed, take immediate steps to identify the source and correct the condition.

3. That the crest of the dam be brought to the design elevation over its entire length.

4. That hole behind the left spillway outlet channel wall be filled.

5. That a formal surveillance and downstream warning system be developed by the owner to be used during periods of high or prolonger precipitation.

SUBMITTED:

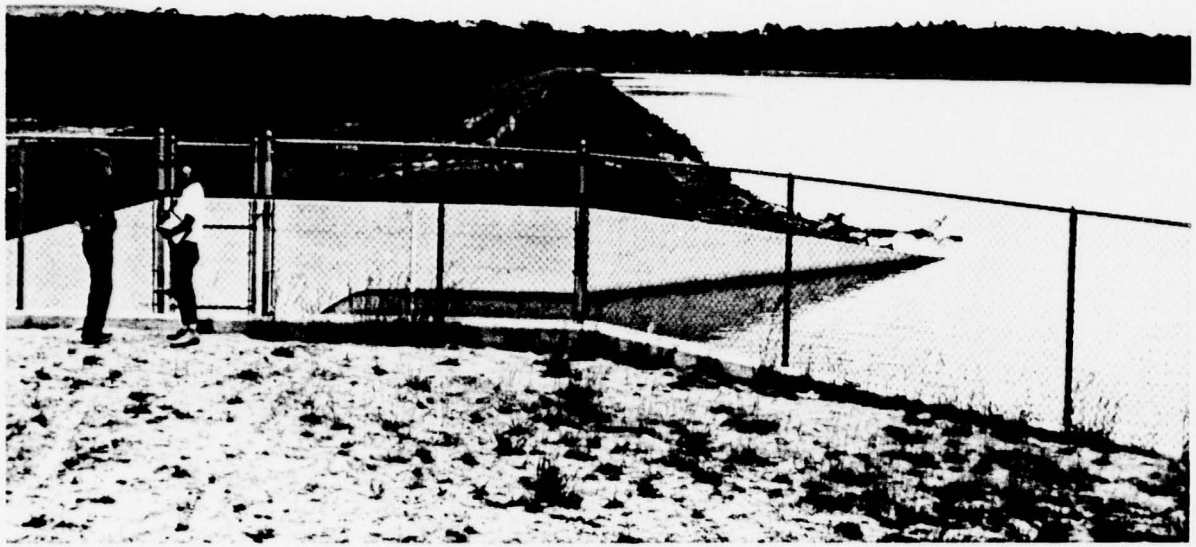
BERGER ASSOCIATES, INC.
HARRISBURG, PA.

DATE: August 24, 1979

APPROVED:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DATE: 7 Sep 79



OVERVIEW

TOWAMENSING TRAILS DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

TOWAMENSING TRAILS DAM

NDI-ID NO. PA-00920
DER-ID NO. 13-108

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

The Towamensing Trails Dam is a 38 foot high zoned earthfill dam with an embankment length of about 3200 feet. Impervious material forms the upstream section of the embankment and has a surface slope of 3H to 1V. Random fill makes up the remaining portion of the embankment and forms a downstream slope of 2.5H to 1V. An internal drainage system includes a vertical stone drain 30 inches in width over the major length of the embankment. This vertical drain connects to a horizontal blanket drain which discharges into a 12-inch diameter perforated drain pipe just beneath the downstream toe of the embankment. ~~Refer to Appendix F, Plate V for typical sections~~. A five foot deep key trench of impervious soil is located at the upstream toe of the embankment. This trench has a bottom width of 30 feet.

The spillway, located at the left abutment, is a 50 foot wide concrete ogee section with a crest elevation of 1,645. Design crest elevation of the embankment is 1650.5. The outlet channel for the spillway is paved with concrete and has concrete training walls extending to a point 300 feet downstream from the spillway. Beyond the paved area

the channel is lined with riprap for about an additional 1100 feet to where the channel joins the original Wolf Run stream. Refer to Appendix F, Plate VII for spillway information.

The outlet works for this dam consists of about 200 lineal feet of 36-inch diameter reinforced concrete pressure pipe supported on a concrete cradle. Upstream discharge control is provided by means of a sloping slide gate with operation control from the top of the dam. Concrete cutoff collars are provided along this pipe on 16 foot centers. A reinforced concrete impact type energy dissipator is located at the downstream end of the outlet pipe. Refer to Appendix F, Plate VI for outlet works information.

B. Location: Penn Forest Township
U.S.G.S. Quadrangle, Pohopoco, Pa.
Latitude: 40°-59.8', Longitude: 75°-34.2'
Refer to Appendix F, Plates I and II

C. Size Classification: Intermediate, 38 feet high;
3,001 acre-feet.

D. Hazard Classification: High (See Section 3.1.E).

E. Ownership: Broadscope, Inc.
4333 Linglestown Road
Harrisburg, PA. 17112

F. Purpose: Recreation.

G. Design and Construction History

The Towamensing Dam was designed in 1973 by Gemini Associates, Consulting Engineers. The permit for construction was issued by the Commonwealth of Pennsylvania in May of 1974 and construction was started on June 18th of that year. Work was done by Melvin G. Meinhart, earthwork contractor and Charles O. Yale, Inc., concrete contractor under supervision and inspection of the design engineer. The project was completed September 9, 1977.

The design engineer reported that two modifications were made to the dam during the construction period. The first was the addition of a foundation drain system to accommodate uncontrolled artesian flow of water in the vicinity of Station 17+00. Refer to Appendix F, Plate VIII. The second was the moving of the outlet structure 10 feet upstream to improve foundation conditions. This latter action caused a slide to occur above the outlet structure in May 1978. This situation is described in Section 3 of this report.

H. Normal Operating Procedures

This facility is used for recreational purposes by the surrounding residential development. Its primary purpose is to provide a uniform lake surface. The operation of the dam is directed to this end. The 36-inch blowoff pipe is used for drawdown for maintenance repairs and can be used to drain the lake if necessary in the event of an emergency.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

Computed for this report	1.4
Design Engineer's Value	1.5

B. Discharge at Dam Site (cubic feet per second)
See Appendix C for calculations.

Maximum known flood at dam site, March, 1979	49
Warm water outlet	None
Blowoff pipe at low pool elevation 1620	90
Blowoff pipe at normal pool elevation 1645.1	189
Spillway capacity at maximum pool elevation 1648.5 (low point of embankment	1,216

C. Elevation (feet above mean sea level)

Top of dam (design)	1,650.5
Low point in embankment	1,648.5
Normal pool	1,645.1
Upstream portal invert of blowoff pipe; about:	1,612.85
Downstream portal invert of blowoff pipe; about:	1,612.35
Streambed at centerline of dam; about:	1,612.5

D. Reservoir (miles)

Length of maximum pool	.6
Length of normal pool	.6

E. Storage (acre-feet)

Spillway crest (Elev. 1645.1)	2,350
Top of dam (Elev. 1648.5)	3,001

F. Reservoir Surface (acres)

Top of dam (Elev. 1648.5)	193
Spillway crest (Elev. 1645.1)	190

G. Dam

For general plan and typical sections refer to Appendix F, Plates III through VI.

Type: Earthfill.

Length: 3200 feet.

Height: 38 feet above streambed.

Top Width: 25 feet.

Side Slope: Upstream 3.5H to 1V.
Downstream 2.5H to 1V.

Zoning: Impervious selected fill on upstream side. Random fill on downstream side.

Cutoff: Cutoff trench excavated near upstream toe, maximum bottom width is 30 feet.

Grout Curtain: None.

H. Outlet Conduit

One 36-inch reinforced concrete blowoff pipe on a concrete cradle with a 36-inch slide gate on the upstream end controlled from the top of the dam, and a reinforced concrete impact type energy dissipator at the downstream end.

I. Spillway

Type: Uncontrolled standard ogee weir with chute constructed of concrete slabs and walls.

Length: 50 feet at crest with vertical abutment walls at right and left.

Crest elevation: 1645.1.

J. Regulating Outlet

See Section 1.3.H.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The available engineering information for the design of this dam is quite extensive. These data include complete design drawings; drawings for modifications to the dam, test boring results; report on investigations of foundation conditions which contains geology, foundation and borrow material investigations, laboratory test data, settlement analyses, stability analyses and seepage studies; hydraulic and hydrologic computations and construction specifications.

2.2 CONSTRUCTION

The construction data in the files includes correspondence with PennDER regarding progress, problems and solutions. Special reports were prepared by engineering consultants and the design engineer. Progress reports are on file indicating the percent of completion of major items of work during the construction period.

2.3 OPERATION

This facility is approximately two years old. There were no records of operation in the PennDER files nor did the owner's representative indicate that any such records exist.

2.4 EVALUATION

A. Availability

The engineering information available for examination is reasonably complete. Refer to Section 2.1 above.

B. Adequacy

The available engineering data is considered sufficient to make a reasonable assessment of the condition of the dam and its appurtenances.

C. Operating Records

There are no operating records for this dam.

D. Post Construction Changes

With the exception of the corrective measures taken to stabilize a slope problem, there have been no modifications or changes reported since the dam was completed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of the Towamensing Dam is good. The major concern is the amount of erosion that is occurring on the downstream slope of the embankment. Maintenance effort to stabilize this condition is deemed necessary. The observed seepage and boil condition downstream from the toe of the embankment is also of concern. The visual inspection check list is in Appendix A of this report. Photographs taken during the inspection are reproduced in Appendix E.

B. Embankment

The visual inspection of the embankment revealed numerous bare and rutted erosion scars on the surface at random locations along the entire length of the embankment. The basic soil texture is sandy silt and is vulnerable to erosive action. The downstream slope cover is thin weed growth. The slope surface is uniform at 2.5H to 1V throughout. One exception is that portion of the slope directly above the outlet structure where the structure was moved ten feet upstream during construction. This change steepened the slope above the structure to about 2H to 1V. A slide developed in this area after construction was completed and was corrected at that time. Other than the erosion condition, there were no other signs of distress on the downstream slope.

The upstream slope cover is dumped rock. This surface does not show any signs of displacement or distress and appears stable. This slope was measured at 3.4H to 1V and appears to be stable.

The crest width of the embankment is 25 feet. It is covered with a sparse growth of grass on sandy soil. There was no evidence of cracking or obvious settlement. The surveyed profile shows that the vertical alignment is below the design elevation at several points over its length. These points are at the left abutment with the natural ground, to the left of the spillway; at the right abutment with the original ground; and at three other locations: 200 feet right of the spillway wall, 1800 feet right of spillway wall and 2200 feet right of spillway wall.

Several seepage points were observed during this inspection. All were downstream from the toe of the embankment. Seepage was not detected anywhere on the actual slope surface.

Slightly wet areas were observed in the swale area just beyond the downstream toe at 50 feet left of the outlet structure and 20 feet right of the outlet structure. There was no flow from either of these areas.

The owners representative indicated that the entire area, upon which the embankment is built, was a former swampy wetland and that natural springs were abundant. Water bubbled to the surface from many springs thus forming the headwaters for Wolf Run.

One such bubbling seepage was noted about 50 feet downstream from the toe of the embankment just to the left of the outlet channel. This water was constantly bubbling from the ground creating small mounds of sandy soil at each seepage point. The source points moved at random within a small 4 to 6 foot area during this observation. The water was clean and cold. Because of the number of seepage points, it was not possible to estimate the total flow.

C. Appurtenant Structures

The appurtenant structures for this facility include an uncontrolled concrete ogee spillway, spillway outlet channel, wall and riprap section, intake structure, control gate, outlet structure and outlet channel.

The ogee spillway section was observed to be in good condition. There was no evidence of cracks or other structural distress in the weir, walls or outlet channel slab. Considerable amounts of logs and tree limbs are strewn along the length of the paved channel. One hole was noted behind the left wall of the outlet channel about 100 feet upstream from the downstream end. This hole is about 4 feet from the wall and should be filled. The outlet channel downstream from the paved section is lined with riprap to its terminus at Wolf Run. This lining is in good condition.

The intake structure is submerged upstream from the embankment and was not inspected. The outlet conduit is a 36-inch diameter reinforced concrete pipe with eight anti-seepage collars on 16 foot centers all beneath the upstream portion of the embankment. The discharge is controlled at the inlet structure by means of a sloping 36 inch square slide gate. This gate is controlled by an exposed gate hoist located on the crest of the embankment. Refer to Appendix F, Plate VI and Appendix E, Plate E-II. This control is in good condition and was operated at the time of this inspection.

The outlet to the 36-inch pipe is a concrete energy dissipator with a concrete baffle. It is also in good condition.

A discharge pipe from an artesian condition within the foundation of the embankment enters this impact basin through a 12-inch diameter pipe in the right side wall. There was a steady flow of water from this pipe estimated at 150 gpm. Refer to Appendix F, Plate VIII for plan of pipe system.

D. Reservoir Area

The Towamensing Dam is a private facility for the use of residents of the surrounding development. Cottages and homes, boat docks, beaches and woodlands make up the immediate reservoir area. One island is located in the lake. There is no evidence or reported problems with sediment to date. The reservoir slopes are moderate and appear stable.

E. Downstream Channel

This dam forms the headwaters for Wolf Run which is a tributary to the larger Mud Run. The downstream channel can be described as typical mountain stream with woodland and brush covered overbanks. One service station is located about 1-1/2 miles downstream and about 50 persons are estimated to reside within the flood plain within the next mile near the village of Albrightsville. Because of the hazard of loss of life to more than a few persons, in the event of a dam break, the hazard classification for this facility is "High".

3.2 EVALUATION

The visual inspection of this facility indicates that the dam is in good condition. There are several items, however, that should be attended to in order to insure the continued satisfactory performance of the dam. The first item is the correction of the erosion scars on the downstream slope and the future control over the entire area; the second is the close and regular observation of the bubbling seepage downstream from the toe of the embankment noting and recording any change in volume or clarity. A third item is bringing the crest of the embankment to the design elevation over its entire length, especially at its abutments. The hole behind the left spillway channel wall should be filled.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The Towamensing Trails Dam was constructed to provide a private recreational lake for the surrounding residential development. The water level is maintained as near to the uncontrolled spillway as possible. The lake area encompasses many natural springs which originally formed the headwaters for Wolf Run. The runoff from the surrounding 1.4 square mile drainage area supplements the primary spring source of water.

The 36-inch upstream slide gate controls the discharge through the 36-inch diameter reinforced concrete outlet conduit. This pipe serves as the drawdown control and can be used in the event of an emergency. Refer to Appendix F, Plate VI and Appendix E, Plate E-II for photograph.

A special drain system, which was installed to control a constant artesian flow of water from one of the investigation test borings, discharges into the impact basin and provides the minimum flow for Wolf Run.

4.2 MAINTENANCE OF DAM

The maintenance of the dam centers primarily on the slope cover. As this facility is about two years old, the major problem is one of getting cover to grow to control the erosion of the slopes. There is no need for cutting at this time. The survey profile of the dam indicates a need to fill certain areas on the crest of the embankment to bring it up to design elevation. The corrective measures to stabilize the slide on the embankment slope above the outlet structure appear to be satisfactory.

4.3 Maintenance of Operating Facilities

The operating facilities of this dam are good. The concrete ogee spillway, its wall and outlet channel are all in good condition.

The slide gate, which controls the discharge through the outlet conduit, was operated satisfactorily during this inspection.

4.4 WARNING SYSTEM

There is no formally organized surveillance or downstream warning system in operation for this dam.

4.5 EVALUATION

The operating facilities of this dam are good. This conclusion is based on the general appearance of the dam and the operating condition of the outlet control gate.

Attention should be given to the correction of the erosion scars on the downstream slope and filling of areas to design elevation along the crest of the embankment.

A formal surveillance and downstream warning system should be developed for use during periods of prolonged or heavy rainfall.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analyses available from PennDER for Towamensing Trails Dam were extensive. A spillway rating curve, area-capacity curve, outlet pipes rating curve, design flood hydrograph and flood routing were all contained in the PennDER files. The designer's computations are in reasonably close agreement with the computations contained in Appendix C of this report.

The design flood hydrograph used by the designer was based on an SCS freeboard hydrograph, having 13 inches of rainfall and producing a peak inflow of 10,285 cfs. When routed through the reservoir, this flood caused the pond water level to rise to about 2.95 feet above the spillway crest.

B. Experience Data

The maximum flood experienced at Towamensing Trails Dam since it was constructed in 1977, occurred in March, 1979. During this flood, the pool level rose to 0.4 feet above the spillway crest. This storm was passed without difficulty.

C. Visual Observations

On the date of the inspection no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtopped.

D. Overtopping Potential

Towamensing Trails Dam has a total storage capacity of 3,001 acre-feet and the overall height is 38 feet above the streambed. These dimensions indicate a size classification of "Intermediate". The hazard classification for this dam is "High" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the PMF (Probable Maximum Flood). For this dam the PMF peak inflow is 2,677 cfs (see Appendix C for hydraulic calculations).

Comparison of the estimated PMF peak inflow of 2,677 cfs with the estimated total discharge capacity of 1,216 cfs indicates that a potential for overtopping of the Towamensing Trails Dam exists. This discharge is based on the present low point in the crest at Elev. 1648.5.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 84% of a PMF, based on the present low point in the crest profile. If the low areas would be raised to the design crest elevation, the project would pass the full PMF without overtopping.

E. Spillway Adequacy

The intermediate size and high hazard categories, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be the Probable Maximum Flood.

Calculations show that the spillway discharge capacity and reservoir storage capacity, based on the present low point in the dam profile, combine to handle 84% of the PMF (Refer to Appendix C).

Since the spillway discharge and reservoir storage capacity cannot pass the full PMF without overtopping, but can pass more than one-half the PMF without overtopping, the spillway is considered to be inadequate but not seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

The visual inspection did not find any major signs of distress which signify unstable conditions. The slide problem above the outlet structure has been satisfactorily repaired. There were no other evidences of slides or sloughs and the slopes appear to be stable at the present time. The most significant condition on the embankment, which can pose future stability problems, is the presence of numerous erosion scars accompanied by rutting down the slope. These areas should be repaired and steps taken to insure good stable cover for future protection.

The origin of the seepage condition downstream from the toe of the embankment is uncertain. The geologic report in Appendix D points out the permeable nature of the foundation materials at this site noting that there is opportunity for seepage through the soil overburden as well as through the bedrock. Also that the pressures of the artesian system in the area are in all probability increased due to the added head generated by the reservoir. The seepage points should be located in detail and should be monitored on a regular basis noting and recording flow and clarity. If significant changes are detected, immediate steps should be taken to correct the condition.

2. Appurtenant Structures

The appurtenant structures for this dam include the spillway and its outlet channel, the intake structure and gate and the outlet structure.

The spillway is a concrete ogee section type weir. There was no evidence of displacement or settlement of this structure. The surface condition is good with no deterioration. This condition applies to the walls, and the spillway outlet channel and walls.

The outlet structure is also in good condition. Serious cracks, displacement of slabs or walls or other distress symptoms were not observed.

The control of the outlet control gate is in very good condition and was operated with ease at the time of this inspection.

All appurtenant structures appear to be in sound stable condition.

B. Design and Construction

The design data, reports and correspondence are extensive. The design report for this project identified the foundations as semi-pervious with intermittent layers of pervious sand and gravel. This led to the inclusion of an impervious blanket adjacent to the upstream toe of the embankment and an internal drainage system in the embankment section.

Slope stability analyses considered end of construction, sudden drawdown and steady seepage conditions. Factors of safety were 1.33 for end of construction, 1.0 for sudden drawdown and 1.67 for steady seepage. The calculations were based on laboratory test data along with test boring information. The design was complete and was developed in accordance with current engineering practice.

The information indicates that the dam was constructed over a period of three years (1974-1977). The significant problems that had impact on the stability of the embankment were the development of an embankment slope slide directly above the outlet structure, and the constant artesian flow of water from an investigation test boring. Both problems were remedied and are no longer considered a threat to the stability of the dam.

C. Operating Records

This dam, being only two years old, does not have any operating records.

D. Post Construction Changes

There have been no modifications made to this dam since its completion in 1977. The only change was the remedial measures to correct the slide condition in 1978.

E. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 7 - ASSESSMENT & RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of the design drawings and the historical records of the development and operation indicates that this dam is in good condition. The inspection did detect erosion distress on the embankment. There were also signs of artesian seepage downstream from the toe of the embankment. There were several items noted which require maintenance attention. These include filling of low points on the crest of the embankment, the correction of erosion scars and the repair of a small hole behind the left spillway approach channel wall.

In accordance with the Corps of Engineers evaluation guidelines, the spillway is inadequate for passing the full PMF peak inflow without overtopping the dam. The combination of storage and spillway capacity is sufficient for passing 84 percent of the PMF and although the spillway is inadequate, it is not considered to be seriously inadequate. If the low areas would be raised to the design crest elevation, the project would pass the full PMF without overtopping the dam.

B. Adequacy of Information

The available engineering data, the available drawings, reports and the observed physical conditions are judged sufficient for making a reasonable assessment of the overall condition of the dam.

C. Urgency

The recommendations presented below should be implemented without delay.

D. Necessity for Additional Studies

Additional studies are not required at this time.

7.2 RECOMMENDATIONS

A. Facilities

In order to assure the continued satisfactory operation of this dam, the following recommendations are presented for implementation by the owner:

1. That the erosion scars on the downstream slope be repaired and that steps be taken to improve the slope cover to protect against future erosion of the slopes.

2. That the seepage condition downstream from the toe of the embankment be monitored on a regular basis noting and recording volume and clarity. If increase in volume or any turbidity is observed, take immediate steps to identify and correct the condition.

3. That the crest of the dam be brought to the design elevation over its entire length.

4. That the hole behind the left spillway outlet channel wall be filled.

B. Operation and Maintenance Procedures

1. That a formal surveillance and downstream warning system be developed to be used during periods of heavy or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 13-108 NDI NO. PA-00920

NAME OF DAM Towamensing Trails Dam HAZARD CATEGORY High

TYPE OF DAM Earth Embankment

LOCATION Penn Forest TOWNSHIP Carbon COUNTY, PENNSYLVANIA

INSPECTION DATE 6-19-79 WEATHER Sunny - Warm TEMPERATURE 70 - 80

INSPECTORS: R. Houseal (Recorder) OWNER'S REPRESENTATIVE(s):

H. Jongsma Bert Campbell

R. Shireman

J. Watson

NORMAL POOL ELEVATION: 1645 AT TIME OF INSPECTION:

BREAST ELEVATION: 1650 POOL ELEVATION: 1645

SPILLWAY ELEVATION: 1645 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: 0.4' March 14, 15, 16, 1979

GENERAL COMMENTS:

Gate opened in March, 1979, and during inspection.

Two modifications during construction.

1. Addition of pipe in artesian (bore hole) to the outlet channel.
2. Moved outlet structure 10' upstream. This caused a steepening of the slope in this area and resulted in a slide.

General appearance of the dam is good.

NDI NO. PA-00 920

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None - except erosion sloughage and rutting on downstream slope.
B. UNUSUAL MOVEMENT BEYOND TOE	None observed.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	Previous slide above outlet structure corrected. Result of slope change in this area during construction. Sloughing on surface of downstream slope due to erosion. Sandy soil very susceptible to this action.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Horizontal - good. See profile plate A-II.
E. RIPRAP FAILURES	None.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good.
G. SEEPAGE	Slight seepage at toe of downstream slope left of outlet - 50'± also about 20' right of outlet at toe.
H. DRAINS	Vertical filter drain + 12" perforated pipe laterally below toe. Special drain 12" diameter pipe from artesian problem.
J. GAGES & RECORDER	Staff gage on right spillway wall.
K. COVER (GROWTH)	Downstream slope light weeds. Many erosion scars and surface sloughs. Upstream - dumped rock. Top - thin grass, sandy soil.

NDI NO. PA-00920

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Sloped slide gate with control on concrete pedestal located on top of embankment. Armco Control. This is an upstream control.
B. OUTLET STRUCTURE	36" Ø R.C. pipe discharging into concrete stilling basin with impact baffel. Low flow slot at end of basin.
C. OUTLET CHANNEL	Nearly level riprap channel.
D. GATES	Gate on submerged upstream inlet for drawdown or blowoff. Gate was opened for this inspection.
E. EMERGENCY GATE	Gate on submerged upstream inlet for drawdown or blowoff. Gate was opened for this inspection.
F. OPERATION & CONTROL	Gate opened at least once a year.
G. BRIDGE (ACCESS)	None.

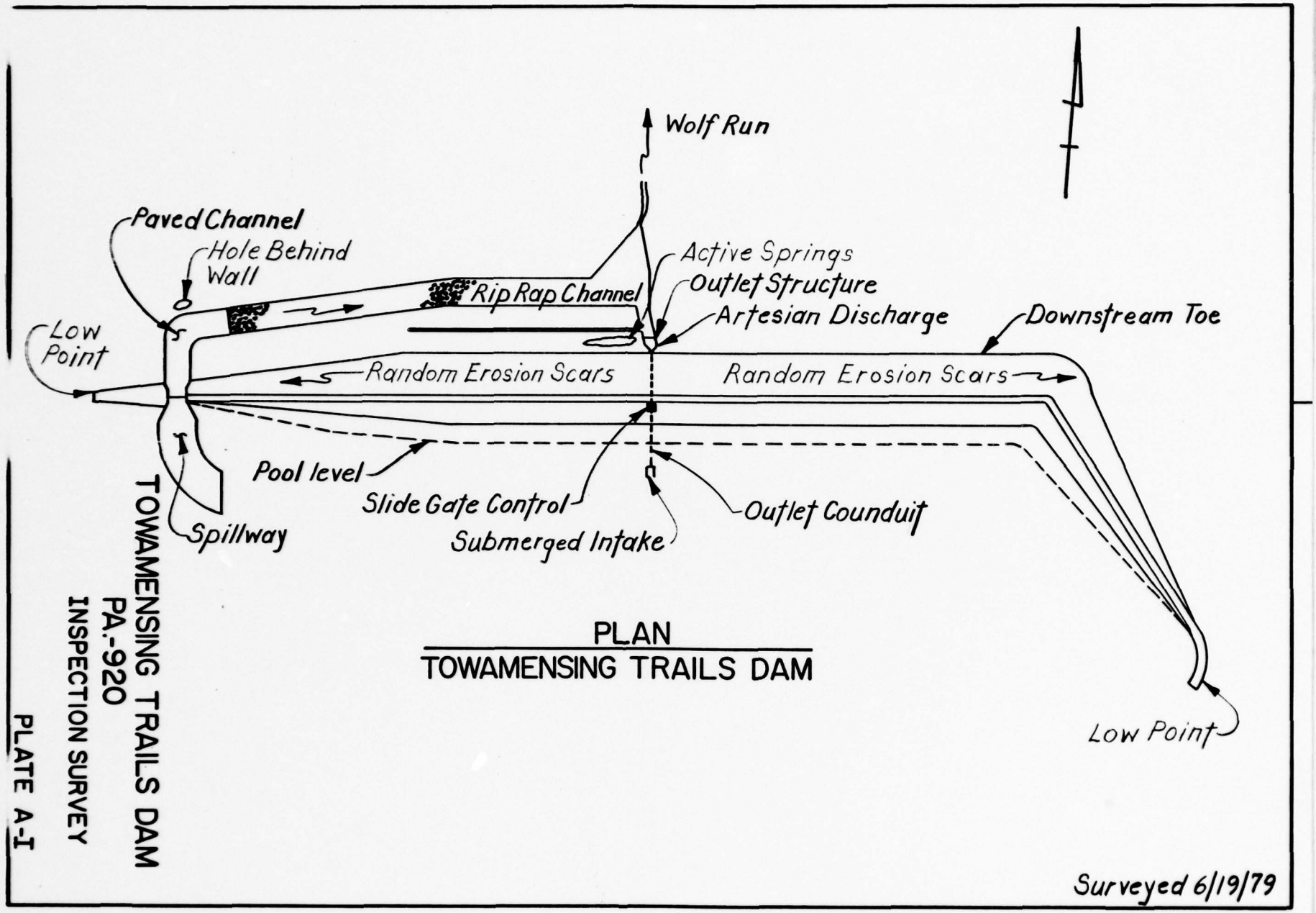
NDI NO. PA-00 920

VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Approach is directly from the left side of the reservoir.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Concrete ogee section - good condition. All concrete walls and downstream channel slab in good condition. No deterioration or cracks.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	Concrete slab with concrete training walls. No stilling basin. Beyond concrete stone lined channel 12"± diameter hole 4' from left training wall 100'± upstream from end. Channel strewn with dead wood logs from spillway to end of concrete.
D. BRIDGE & PIERS	None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	None.

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	Located on right spillway abutment wall.
Other	None.
RESERVOIR	
Slopes	Wooded.
Sedimentation	None reported.
Watershed Description	Timber.
DOWNSTREAM CHANNEL	
Condition	Natural stream.
Slopes	Wooded.
Approximate Population	Gas Station - 1-1/2 downstream. 50±.
No. Homes	20±

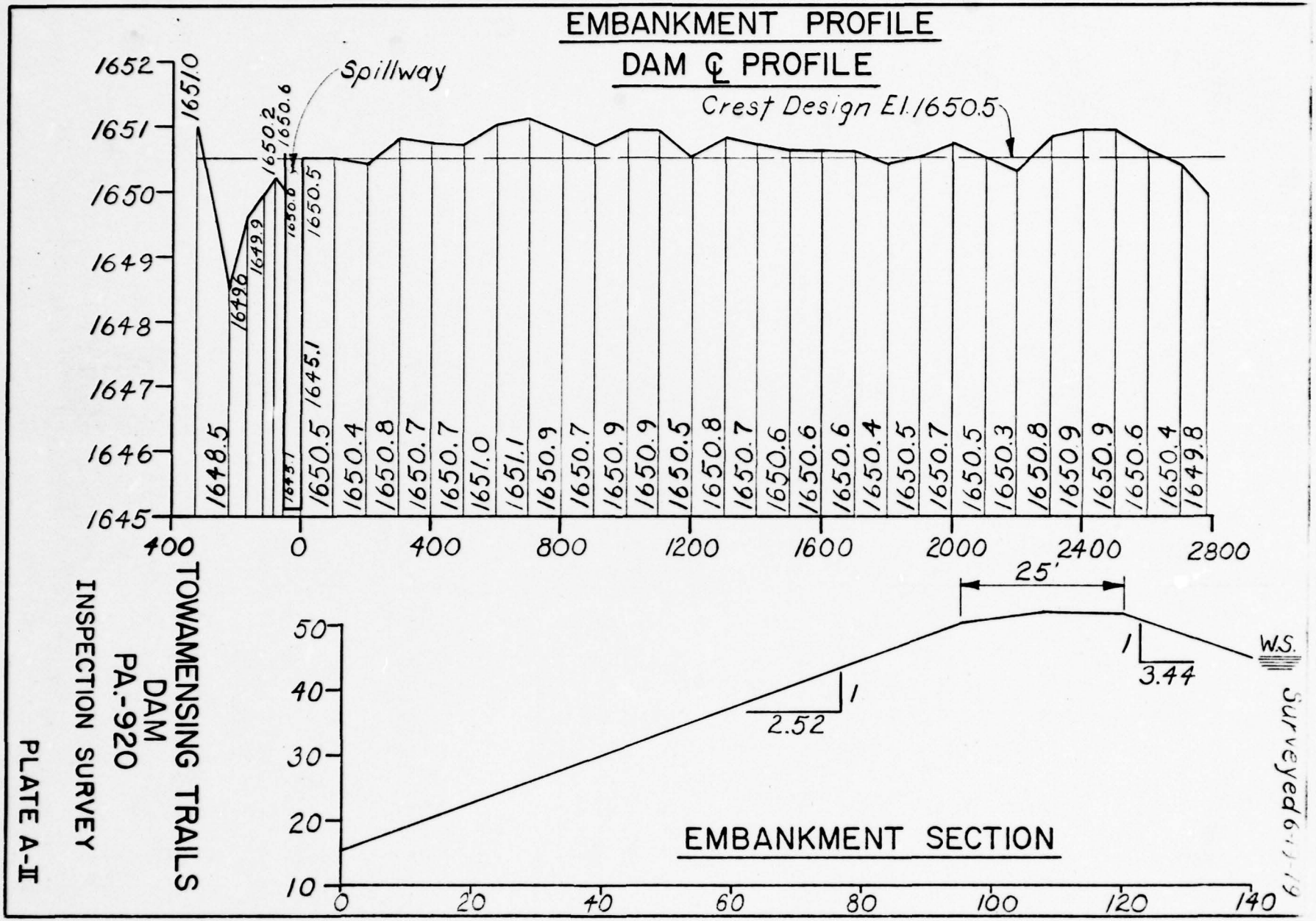


PLAN

TOWAMENSING TRAILS DAM

TOWAMENSING TRAILS DAM
PA.-920
INSPECTION SURVEY

PLATE A-I


EMBANKMENT PROFILE
DAM ℄ PROFILE
Spillway
Crest Design El.1650.5
1652
1651
1650
1649
1648
1647
1646
1645
1651.0
1650.2
1650.6
1649.6
1649.9
1650.6
1650.5
1648.5
1645.1
1650.5
1650.4
1650.8
1650.7
1650.7
1651.0
1651.1
1650.9
1650.7
1650.9
1650.9
1650.5
1650.8
1650.7
1650.6
1650.6
1650.6
1650.4
1650.5
1650.7
1650.5
1650.3
1650.8
1650.9
1650.9
1650.6
1650.4
1649.8
400
0
400
800
1200
1600
2000
2400
2800
25'
1
3.44
W.S.
1
2.52
50
40
30
20
10
0
20
40
60
80
100
120
140
EMBANKMENT SECTION
TOWAMENSING TRAILS
DAM
PA.-920
INSPECTION SURVEY
PLATE A-II
Surveyed 6-1-79

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 13-108 NDI NO. PA-00 920

NAME OF DAM Towamensing Trails Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	None. Design drawings only.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle See Plate II, Appendix F
CONSTRUCTION HISTORY	Contained in inspection reports and correspondence in the PennDER files.
GENERAL PLAN OF DAM	General plan with PennDER files.
TYPICAL SECTIONS OF DAM	In PennDER files with design drawings.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	All information on these items are in the PennDER files. Included with the design drawings.

NDI NO. PA-00920

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	PennDER "C" curve used to establish the inflow.
DESIGN REPORTS	Foundation Report.
GEOLOGY REPORTS	Complete foundation report, including subsurface investigations, laboratory test information, geologic descriptions, and stability studies.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Hydraulic calculations, slope stability computations.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	Included in the foundation report on file with PennDER.
POST CONSTRUCTION SURVEYS OF DAM	Only that to correct slide on slope of embankment above outlet structure.
BORROW SOURCES	Information included in foundation report.

NDI NO. PA-00 920

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Revised location of outlet structure 10 feet upstream. Additional drain system to control artesian flow of water.
HIGH POOL RECORDS	None on record.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	Investigation of surface slide on downstream slope.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	Surface slide on slope above outlet structure. Description in file correspondence.
MAINTENANCE & OPERATION RECORDS	Dam operated for community recreation.
SPILLWAY PLAN, SECTIONS AND DETAILS	Plans contained in design drawings in PennDER files.

NDI NO. PA-00 920

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	Information on gate control shown on the design drawings.
CONSTRUCTION RECORDS	Inspection reports and correspondence.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Correspondence and inspection reports describe the slope slide problem and seepage conditions.
MISCELLANEOUS	

NDI NO. PA-00 920

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Woodlands

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 1645 2,350 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev.1650 3,001 Acre-Feet

MAXIMUM DESIGN POOL: Elev. 1647±

TOP DAM: Elev. 1650

SPILLWAY:

a. Elevation 1645

b. Type Concrete - Ogee Section

c. Width 50 feet.

d. Length of ogee 10 feet.

e. Location Spillover Left abutment.

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 36" diameter reinforced concrete pipe.

b. Location Near center of embankment (Station 17+35).

c. Entrance inverts Elev. 1612.85

d. Exit inverts Elev. 1612.35

e. Emergency drawdown facilities Same.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: No record.

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

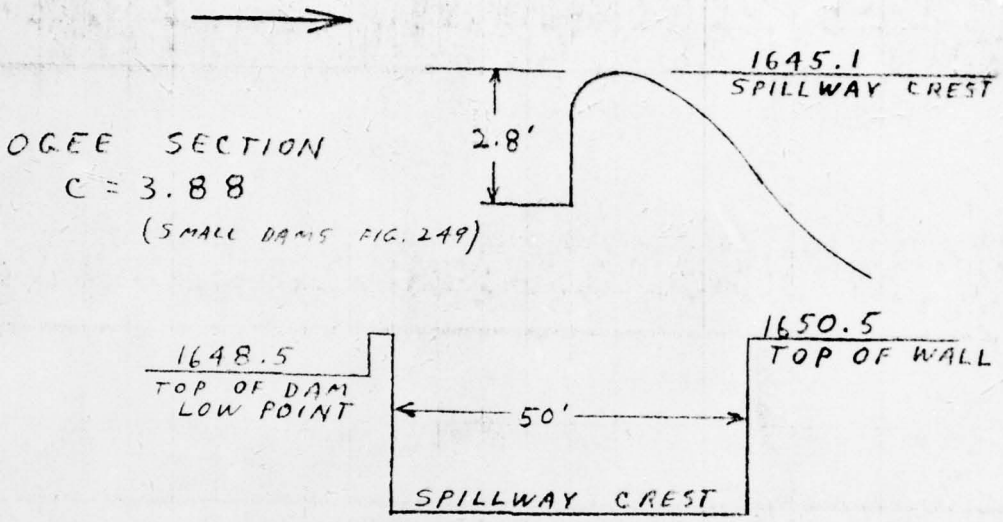
The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

BY _____ DATE _____ BERGER ASSOCIATES SHEET NO. _____ OF _____

SUBJECT TOWAMENSING TRAILS DAM PROJECT D-2490

SPILLWAY RATING



$H = 1648.5 - 1645.1 = 3.4'$

$C = 3.88$

$L = 50$

$$Q = CLH^{3/2}$$

$$= 3.88 \times 50 \times (3.4)^{1.5} = 1216 \text{ CFS}$$

MAXIMUM KNOWN FLOOD AT DAMSITE

IT WAS REPORTED BY THE DAM'S DESIGNER THAT THE MAXIMUM KNOWN FLOOD AT THE TOWAMENSING TRAILS DAM OCCURRED IN MARCH 1979 WHEN THE WATER LEVEL IN THE LAKE REACHED AN ELEVATION 0.4' ABOVE THE SPILLWAY CREST.

$C = 3.88$

$H = 0.4'$

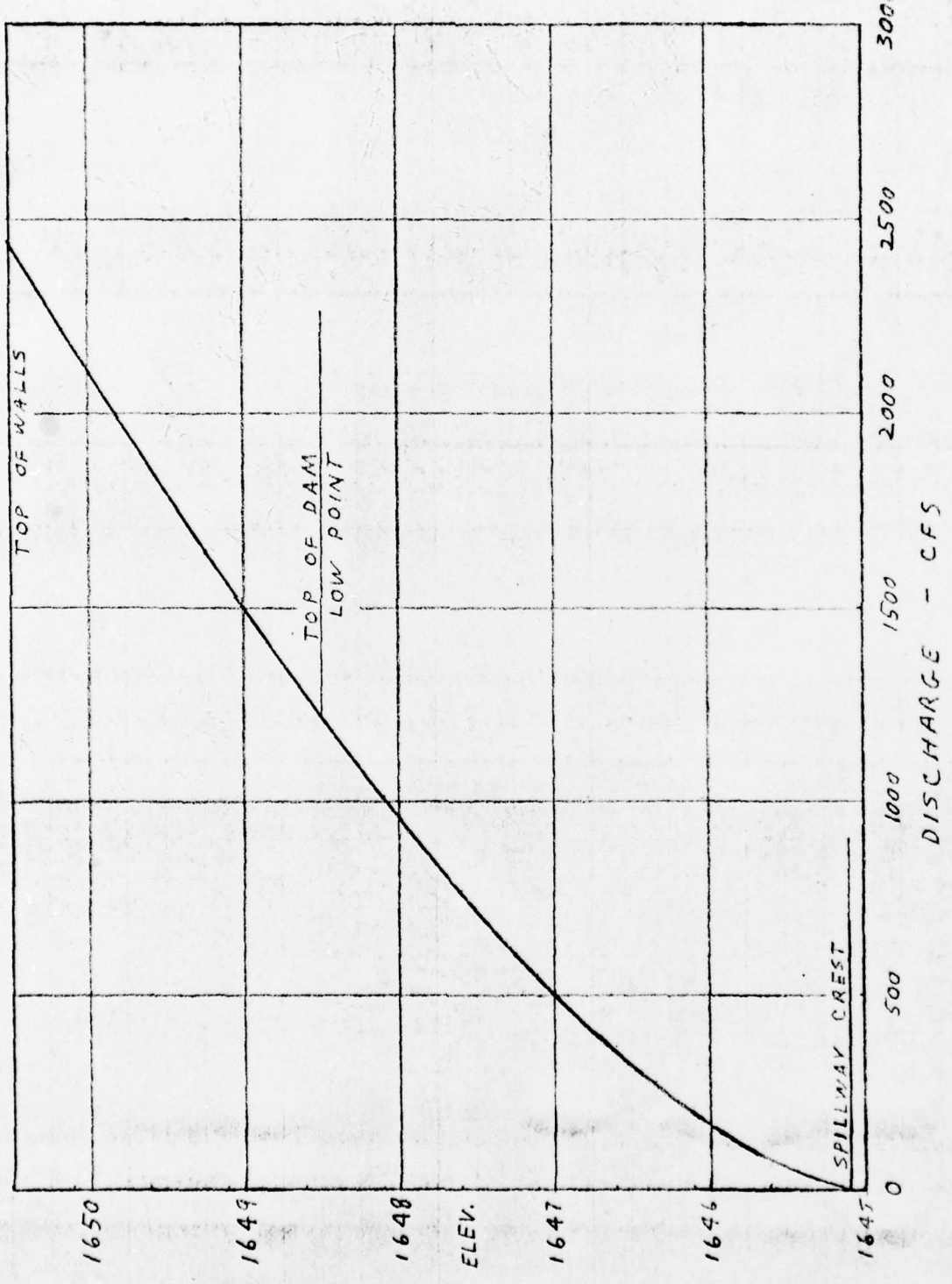
$L = 50'$

$$Q = CLH^{3/2}$$

$$= 3.88 \times 50 \times (.4)^{1.5} = 49 \text{ CFS}$$

BY RLS DATE 7/11/79 BERGER ASSOCIATES SHEET NO. 2 OF
CHKD. BY DATE PROJECT D8496
SUBJECT TOWAMENSING TRAILS DAM

SPILLWAY RATING CURVE



BY _____ DATE 4/1/69 BERGER ASSOCIATES SHEET NO. _____

CHKD. BY _____ DATE _____ PROJECT D894

SUBJECT TOWAMENSING TRAILS DAM

DISCHARGE THROUGH OUTLET WORKS

OUTLET CONDUIT = 3' DIA. R.C.P.

L = 197'

UP STREAM INVERT = 1612.85

CENTER LINE = 1614.35

$Q = C A \sqrt{2gH}$ $\quad C = 0.6$

AT NORMAL POOL LEVEL - 1645.1

$H = 1645.1 - 1614.35 = 30.75$

$Q = 0.6 \times \pi \times (1.5)^2 \times (2 \times 32.2 \times 30.75)^{.5}$

$= 189$ CFS

AT LOW POOL LEVEL - 1620

$H = 1620 - 1614.35 = 5.65$

$Q = 0.6 \times \pi \times (1.5)^2 \times (2 \times 32.2 \times 5.65)^{.5}$

$= 80$ CFS

BY RLS DATE _____ | BERGER ASSOCIATES | SHEET NO. 4 OF _____
CHKD. BY _____ DATE _____ | PROJECT D8490
SUBJECT TOWAMENSING TRAILS DAM

EMBANKMENT RATING

$Q = C L H^{3/2}$

AT ELEV 1649

$2.7 \times 45 \times (.25)^{1.5} = 15$ CFS

AT ELEV 1649.5

$2.7 \times 90 \times (.5)^{1.5} = 86$ CFS

AT ELEV 1650

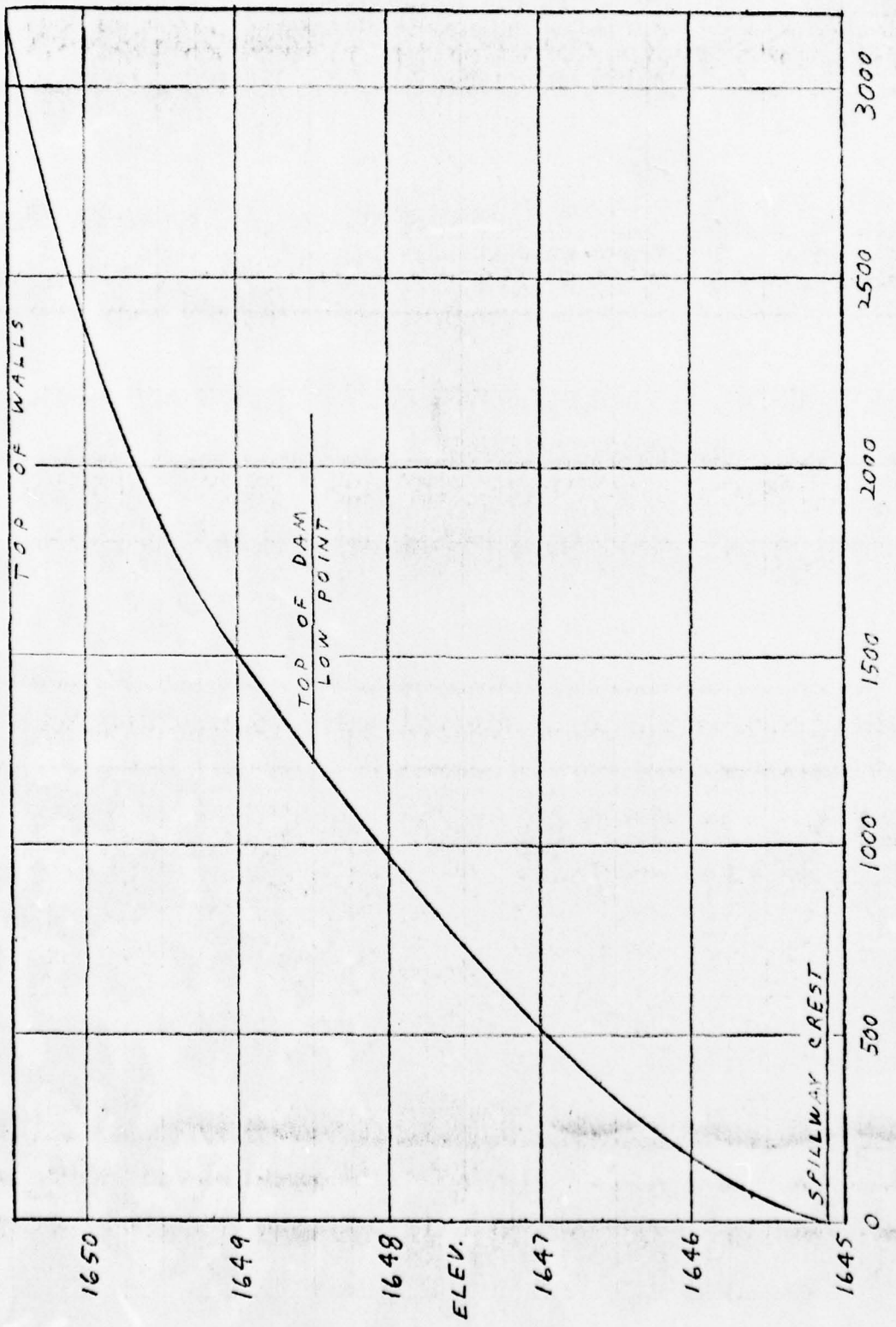
$2.7 \times 95 \times (.95)^{1.5} =$	238	
$2.7 \times 20 \times (.2)^{1.5} =$	5	
$2.7 \times 5 \times (.45)^{1.5} =$	4	
$2.7 \times 50 \times (.25)^{1.5} =$	17	
$2.7 \times 5 \times (.05)^{1.5} =$	—	
$2.7 \times 25 \times (.1)^{1.5} =$	2	$\Sigma = 266$ CFS

AT ELEV 1650.5

$2.7 \times 95 \times (1.45)^{1.5} =$	448	
$2.7 \times 40 \times (.45)^{1.5} =$	33	
$2.7 \times 5 \times (.95)^{1.5} =$	13	
$2.7 \times 50 \times (.75)^{1.5} =$	88	
$2.7 \times 35 \times (.45)^{1.5} =$	29	
$2.7 \times 35 \times (.4)^{1.5} =$	24	
$2.7 \times 100 \times (.4)^{1.5} =$	68	
$2.7 \times 50 \times (.05)^{1.5} =$	2	
$2.7 \times 70 \times (.1)^{1.5} =$	6	
$2.7 \times 75 \times (.05)^{1.5} =$	2	$\Sigma = 713$ CFS

BY RC DATE 11/9/84 BERGER ASSOCIATES SHEET NO.
CHKD. BY DATE PROJECT D8496
SUBJECT TOWAMENSING TRAILS DAM

DISCHARGE RATING CURVE



BY ____ DATE 4/10/79 **BERGER ASSOCIATES** SHEET NO. 6 OF
CHKD. BY ____ DATE ____ PROJECT D8990
SUBJECT TOWAMENSING TRAILS DAM

SIZE CLASSIFICATION

MAXIMUM STORAGE = 3001 ACRE FEET
MAXIMUM HEIGHT = 38 FEET
SIZE CLASSIFICATION IS "INTERMEDIATE"

HAZARD CLASSIFICATION

VILLAGE OF ALBRIGHTSVILLE LIES ALONG THE DOWNSTREAM CHANNEL
USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO THE PROBABLE MAXIMUM FLOOD.

BY ... DATE 7/19/79 | BERGER ASSOCIATES | SHEET NO. 1
CHKD. BY ... DATE ... | PROJECT D8490
SUBJECT TOWAMENSING TRAILS DAM

HEC-1 DATA

DRAINAGE AREA = 1.4 SQ. MI.

DELAWARE BASIN REGION 2

$C_P = 0.45$

$C_T = 2.1$

LONGEST WATERCOURSE = 1.78 MI.

L TO CENTROID = 0.68 MI.

$$T_P = C_T (L \times L_{CA})^{.3}$$

$T_P = 2.22$ HR.

RAINFALL (HMR-33)

INDEX (200 SQ. MI. - 24 HR.) = 22.3"

ZONE 6

INCREMENTAL RAINFALL

6 HR = 113 %

12 HR = 123 %

24 HR = 132 %

48 HR = 143 %

STORAGE = 2350 ACRE-FEET AT SPILLWAY CREST (FROM STATE FILES)

AREAS:

ELEV. 1645.1 = 190 ACRES (FROM STATE FILES)

ELEV. 1660 = 203 ACRES (PLANIMETERED: QUAD SHEET)

ZERO STORAGE ELEVATION

ELEV. = 1645.1 - (STORAGE x 3/AREA)

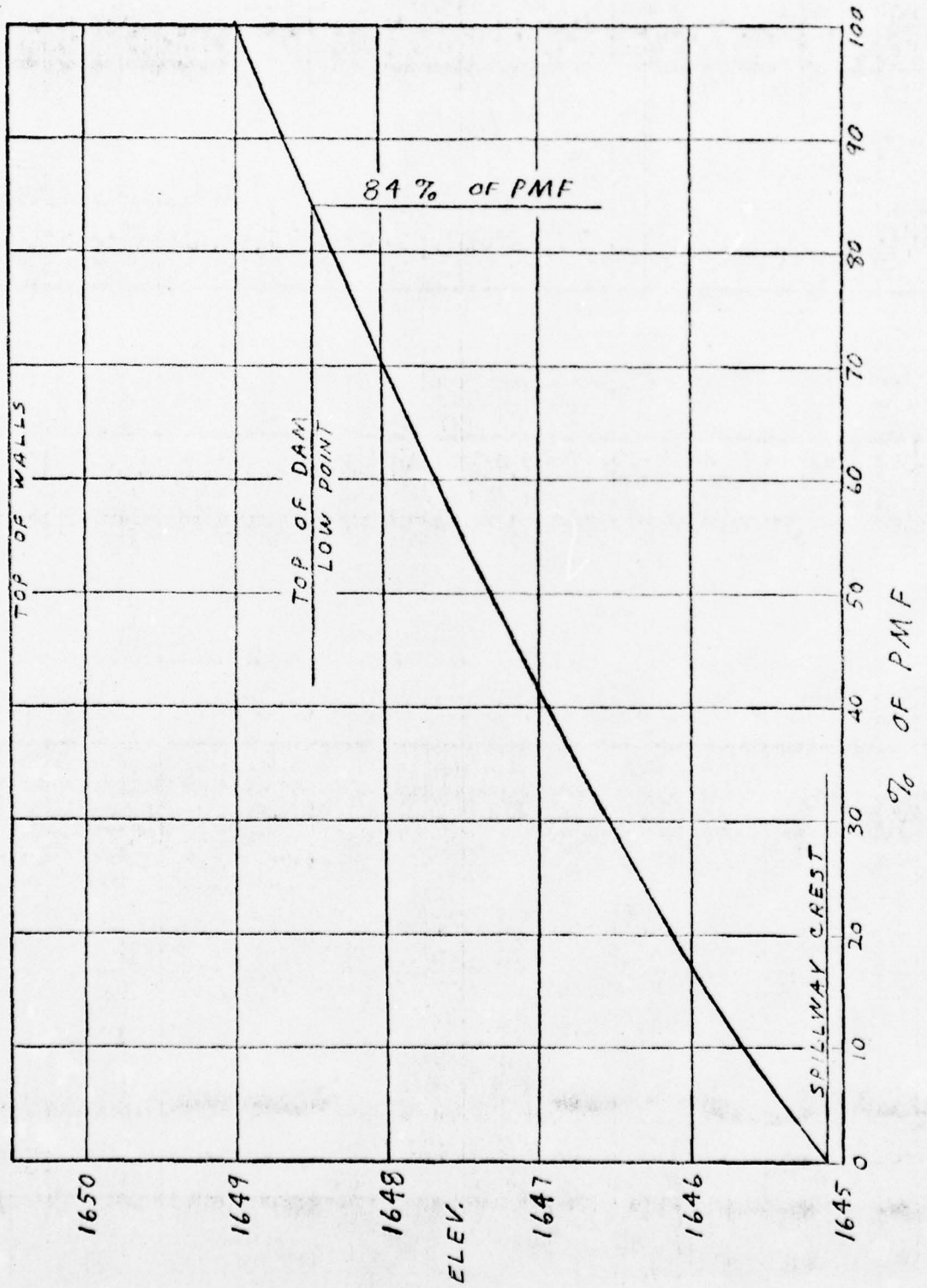
= 1608

BY ... DATE 4-[illegible]-79 BERGER ASSOCIATES SHEET NO. 2

CHKD. BY ... DATE ... PROJECT D84[illegible]

SUBJECT TOWAMENSING TRAILS DAM

SPILLWAY CAPACITY CURVE



FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

```
   1            A1      TOWAMENSING TRAILS DAM ****  WOLF RUN
   2            A2      PENN FOREST TWP., CARBON COUNTY
   3            A3      NDI # PA-00920   PA DER # 13-108
   4            B   300       0      15       0       0       0       0       0      -4       0
   5            B1    5
   6            J     1       9       1
   7            J1    1      .9      .8      .7      .6      .5      .4      .3      .2
   8            K             1                                               1
   9            K1              INFLOW HYDROGRAPH
  10            M     1       1     1.4
  11            P           22.3     113     123     132     143
  12            T                                                       1     .05
  13            W  2.22     .45
  14            X  -1.5    -.05       2
  15            K     1       2                                         1
  16            K1              RESERVOIR ROUTING
  17            Y                                       1       0
  18            Y1    1                                                 2350      -1
  19            Y41645.1  1645.6  1646.1  1646.6  1647.1  1647.6  1648.1  1648.5    1649  1649.5
  20            Y4  1650  1650.5
  21            Y5    0      69     194     364     549     767    1008    1216    1507    1834
  22            Y5 2370    3147
  23            $A    0     190     203
  24            $E 1608  1645.1    1660
  25            $$1645.1
  26            $D1648.5
  27            K    99
```

1 PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
ROUTE HYDROGRAPH TO 2
END OF NETWORK

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 79/07/18.
TIME= 13.04.47.

TOWAMENSING TRAILS DAM **** WOLF RUN
PENN FOREST TWP., CARBON COUNTY
NDI # PA-00920 PA DER # 13-108

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

PENN FOREST TWP., CARBON COUNTY
NDI # PA-00920 PA DER # 13-108

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .30 .20

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.40	0.00	1.40	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.30	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.22 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 81 END-OF-PERIOD ORDINATES, LAG= 2.23 HOURS, CP= .45 VOL= 1.00

6.	23.	47.	76.	108.	138.	161.	178.	186.	182.
170.	159.	148.	138.	129.	120.	112.	104.	97.	90.
84.	79.	73.	68.	64.	59.	55.	51.	48.	45.
42.	39.	36.	34.	31.	29.	27.	25.	24.	22.
21.	19.	18.	17.	16.	15.	14.	13.	12.	11.
10.	10.	9.	8.	8.	7.	7.	6.	6.	5.
5.	5.	4.	4.	4.	4.	3.	3.	3.	3.
2.	2.	2.	2.	2.	2.	2.	2.	1.	1.
1.									

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.51	23.10	2.41	83471.

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	2350.	-1

STAGE	1645.10	1645.60	1646.10	1646.60	1647.10	1647.60	1648.10	1648.50	1649.00	1649.50
	1650.00	1650.50								
FLOW	0.00	69.00	194.00	364.00	549.00	767.00	1008.00	1216.00	1507.00	1834.00
	2370.00	3147.00								

SURFACE AREA=	0.	190.	203.
CAPACITY=	0.	2350.	5277.
ELEVATION=	1608.	1645.	1660.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
1645.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1648.5	0.0	0.0	0.

PEAK OUTFLOW IS 1503. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 1321. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 1141. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 968. AT TIME 45.50 HOURS

PEAK OUTFLOW IS 801. AT TIME 45.50 HOURS

PEAK OUTFLOW IS 640. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 485. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 341. AT TIME 46.25 HOURS

PEAK OUTFLOW IS 199. AT TIME 46.75 HOURS

1 ********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .90	RATIO 3 .80	RATIO 4 .70	RATIO 5 .60	RATIO 6 .50	RATIO 7 .40	RATIO 8 .30	RATIO 9 .20
HYDROGRAPH AT	1	1.40	1	2677.	2409.	2141.	1874.	1606.	1338.	1071.	803.	535.
	(	3.63)	(	75.80)(	68.22)(	60.64)(	53.06)(	45.48)(	37.90)(	30.32)(	22.74)(	15.16)
ROUTED TO	2	1.40	1	1503.	1321.	1141.	968.	801.	640.	485.	341.	199.
	(	3.63)	(	42.57)(	37.41)(	32.30)(	27.42)(	22.68)(	18.12)(	13.74)(	9.65)(	5.64)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1645.10	1645.10	1648.50
STORAGE	2350.	2350.	3001.
OUTFLOW	0.	0.	1216.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1648.99	.49	3096.	1503.	5.25	45.25	0.00
.90	1648.68	.18	3036.	1321.	3.25	45.25	0.00
.80	1648.36	0.00	2973.	1141.	0.00	45.25	0.00
.70	1648.02	0.00	2908.	968.	0.00	45.50	0.00
.60	1647.67	0.00	2841.	801.	0.00	45.50	0.00
.50	1647.31	0.00	2771.	640.	0.00	45.75	0.00
.40	1646.93	0.00	2698.	485.	0.00	46.00	0.00
.30	1646.53	0.00	2622.	341.	0.00	46.25	0.00
.20	1646.11	0.00	2543.	199.	0.00	46.75	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam

Formation Name: Poplar Gap Member of the Catskill Formation.

Lithology: Fine to medium grained gray sandstone, massive beds; two to five feet thick, tend to break up into beds of 1/2 to 3 inches thick. Composed of quartz sand, some quartz pebbles, generally cemented with quartz. A few, scarce, red shale interbeds.

Bedrock - Reservoir

Formation Names: Poplar Gap and Duncannon Members of the Catskill Formation.

Lithology: The Duncannon Member consists of dominantly red sandstones, siltstones and shales.

Structure

The dam is located near the axis of the Unionville Anticline, which strikes about N70°E. Bedding dips are therefore, variable NW to SE. Joints reported in the soils report trend:

N10° -20°W, vertical.
N75° -85°E, dipping 75° to 85° SE.
N17°E, dipping 70°SE.
N80°W, vertical.

The N10°W direction of jointing is also expressed in the air photo fracture traces. The valley of Wolf Run is controlled by these fractures.

Overburden

Logs of fifteen core borings are available. Total thickness of overburden is from 6.5 to 30 feet thick, and is generally 20 to 30 feet thick, except at the abutments. Most of the overburden is generally finer and more clay rich just above the bedrock.

Aquifer Characteristics

The rocks of the Catskill Formation are generally impermeable and ground water movement is along bedding planes and fractures. Where fractures are closely spaced, ground water movement can be quite free. There also appears to be considerable potential for ground water movement in the overburden. The layers described as coarse to medium sand, gravel, sand and gravel have potential as aquifers. "Artesian flows" were noted in several bore holes in the upper few feet of the bedrock. The confining bed in his case would appear to be the less permeable basal layers of overburden. It seems likely that before dam construction, there was considerable movement in this upper bedrock zone, parallel to the N10°W fracture zone, that is, parallel to the course of the creek. numerous springs were reported in the area before dam construction. These may have occurred in areas where the confining layer in the overburden was absent, or had been removed by ground water movement.

Discussion

The preliminary soils report for this dam recommended either grouting or an impervious blanket on the floor of the reservoir adjacent to the embankment. For cost reasons the impervious blanket was preferred. The plans of the dam show that there was a five feet deep cutoff trench at the upstream toe of the embankment, that would be connected with a three feet thick impervious blanket, the width of which was to be determined during construction. However, the copy of the contract documents in the file, makes no mention of the blanket, and it is not clear that it ever was installed.

In any case, the cutoff trench must have bottomed well above bedrock everywhere except at the abutments. As noted above the description of the overburden indicates that it is in part permeable material. There appears to be, therefore, ample opportunities for leakage beneath the dam, both through the overburden and through the bedrock.

Springs are reported to exist now just below the toe of the dam. It is not certain if these seeps pre-date the construction of the dam, or if they are new. Even if they pre-date the dam construction they present a possible channel for leakage. The reservoir now represents increased head on both the artesian system in the upper bedrock and on the permeable zones in the overburden. It is my opinion that these springs be carefully monitored for changes in flow, and/or sediment load.

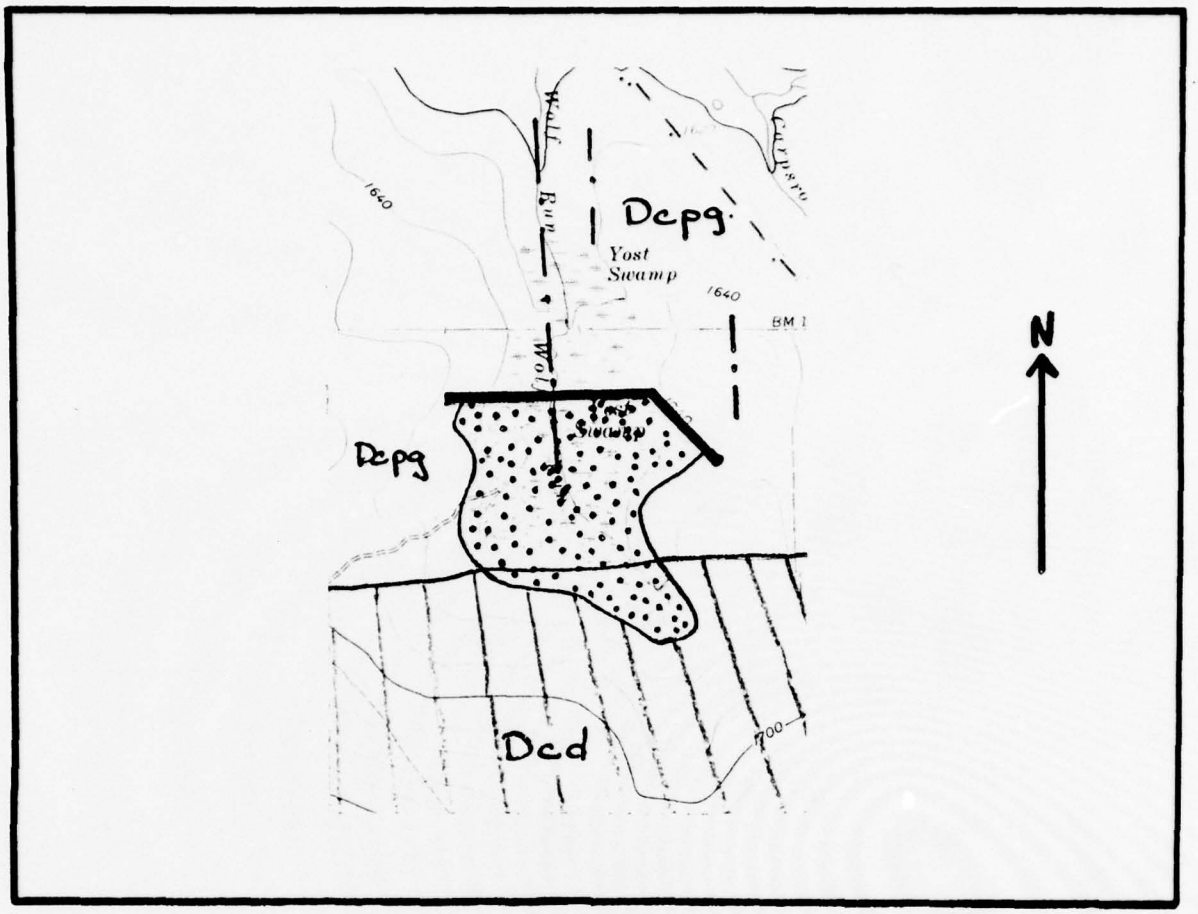
Sources of Information

1. W.D. Sevon (1975). "Geology and Mineral Resources of the Christmans and Pohopoco Mt. Quadrangles, Carbon and Monroe Counties, Pa.". Pa. Geol. Survey, Atlas 195ab.

2. Plans and geologic report in file.

3. Aerial Photographs, scale 1:24,000. Dated 1970.

GEOLOGIC MAP - Towamensing Trails Dam



(geology from Pa. Geol. Surv. Atlas 195ab)

Dcd — Catskill Fm.- Duncannon Member

Dcpg — Catskill Fm.- Poplar Gap Member

reservoir

air photo fracture trace

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET

APPENDIX E

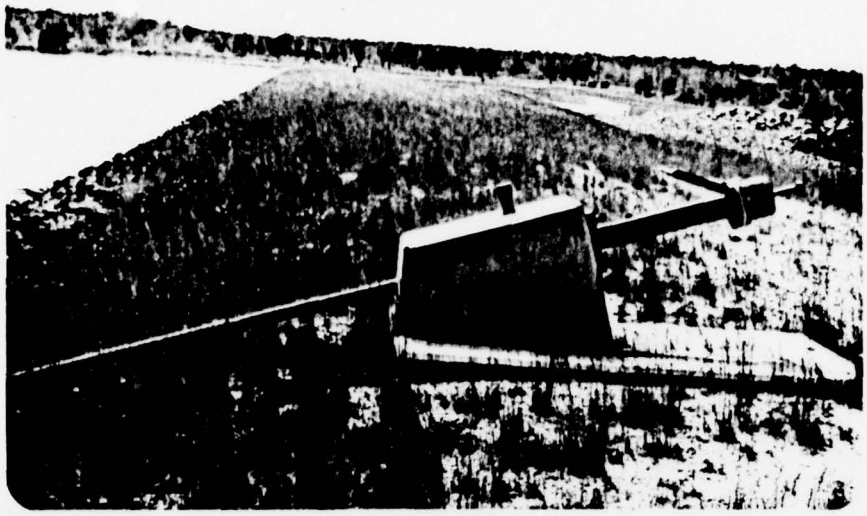
PHOTOGRAPHS

Upstream Slope
Left Abutment

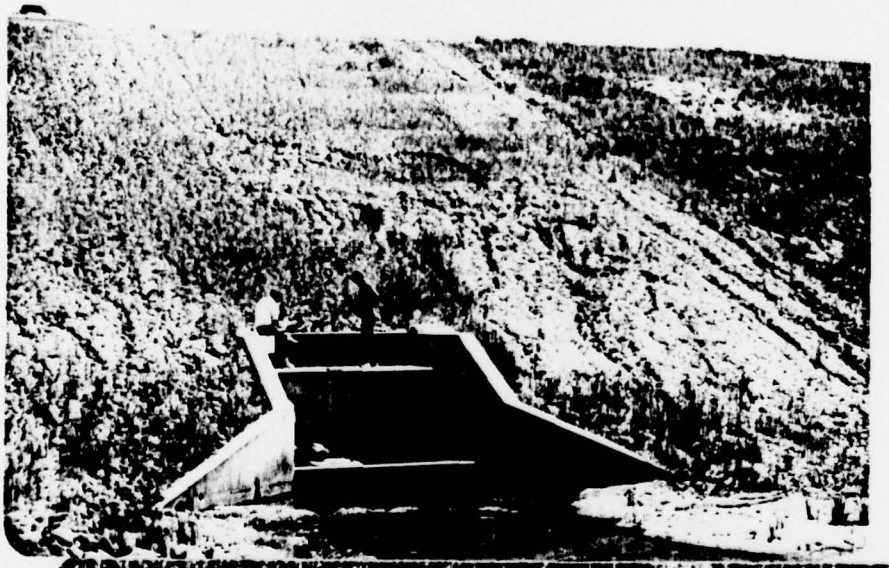
Downstream Slope

Downstream Slope
with
Typical Erosion

PA-920
PLATE E-I



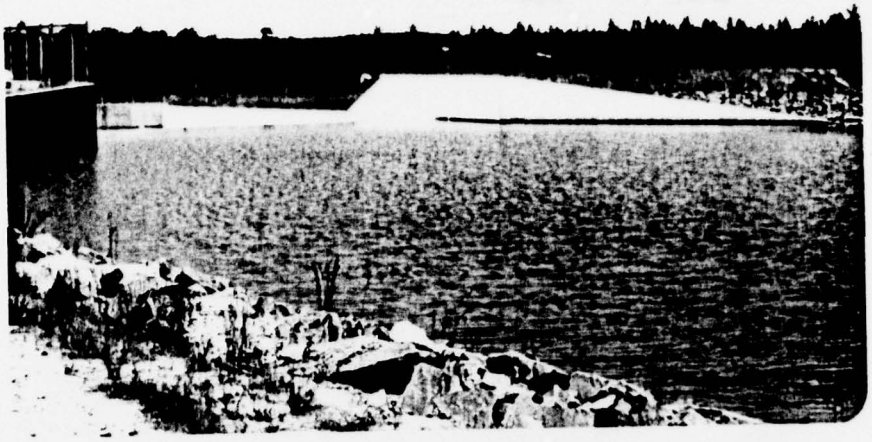
Upstream Valve
Control on
Top of Dam.
Spillway in
Background.



Conduit Outlet
and
Slope Erosion

Springs Downstream
from
Toe of Dam

PA-920
PLATE E-II



Forebay

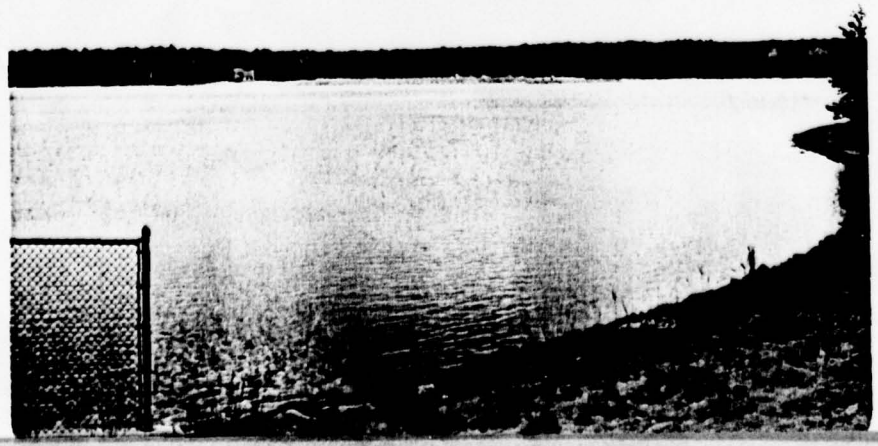
Curved Spillway
Discharge Channel

Riprapped
Spillway Channel

PA-920
PLATE E-III

Spillway
Ogee Section

Crest of Dam
with
Spillway Channel

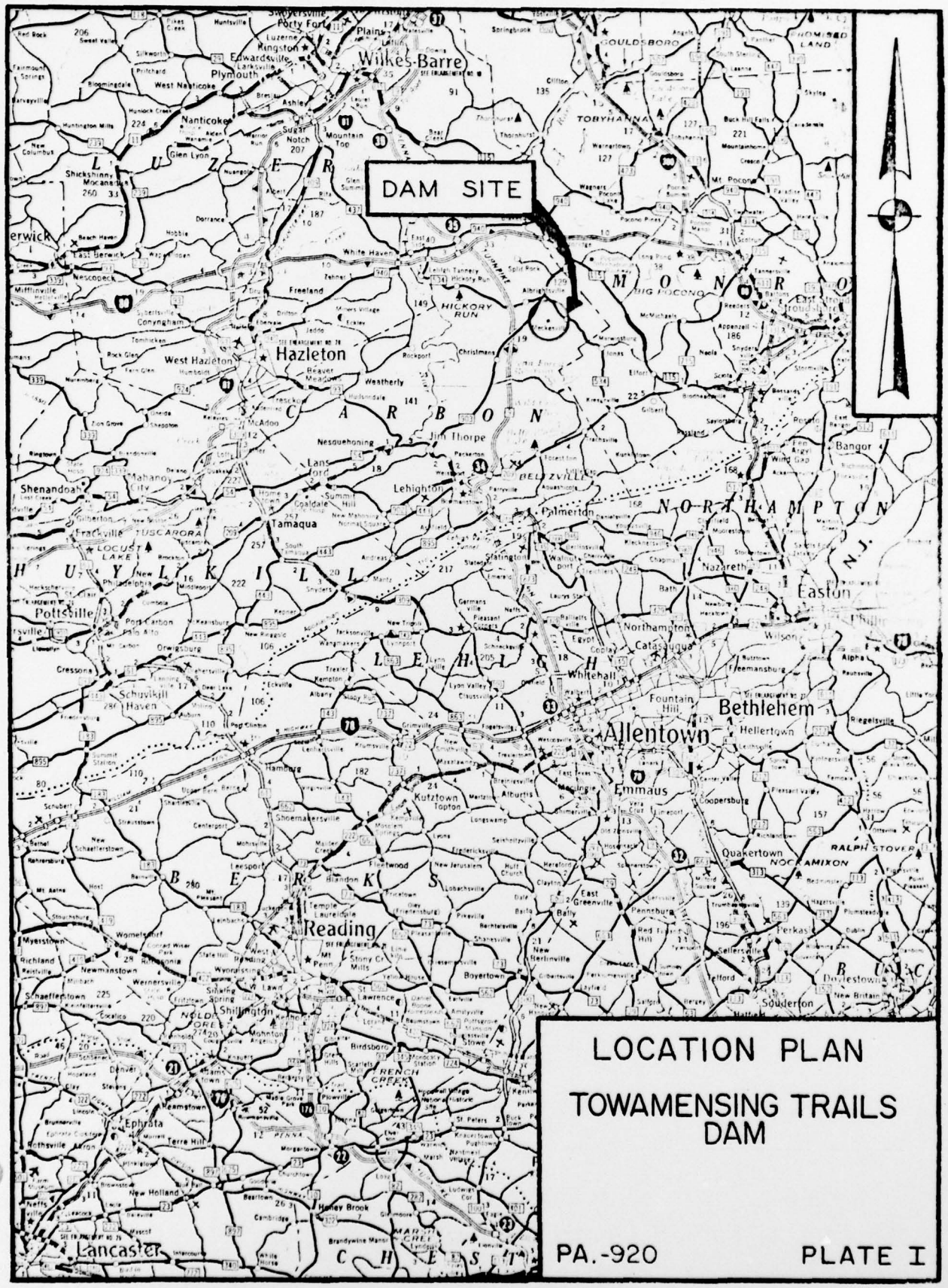


Reservoir

PA-920
PLATE E-IV

APPENDIX F

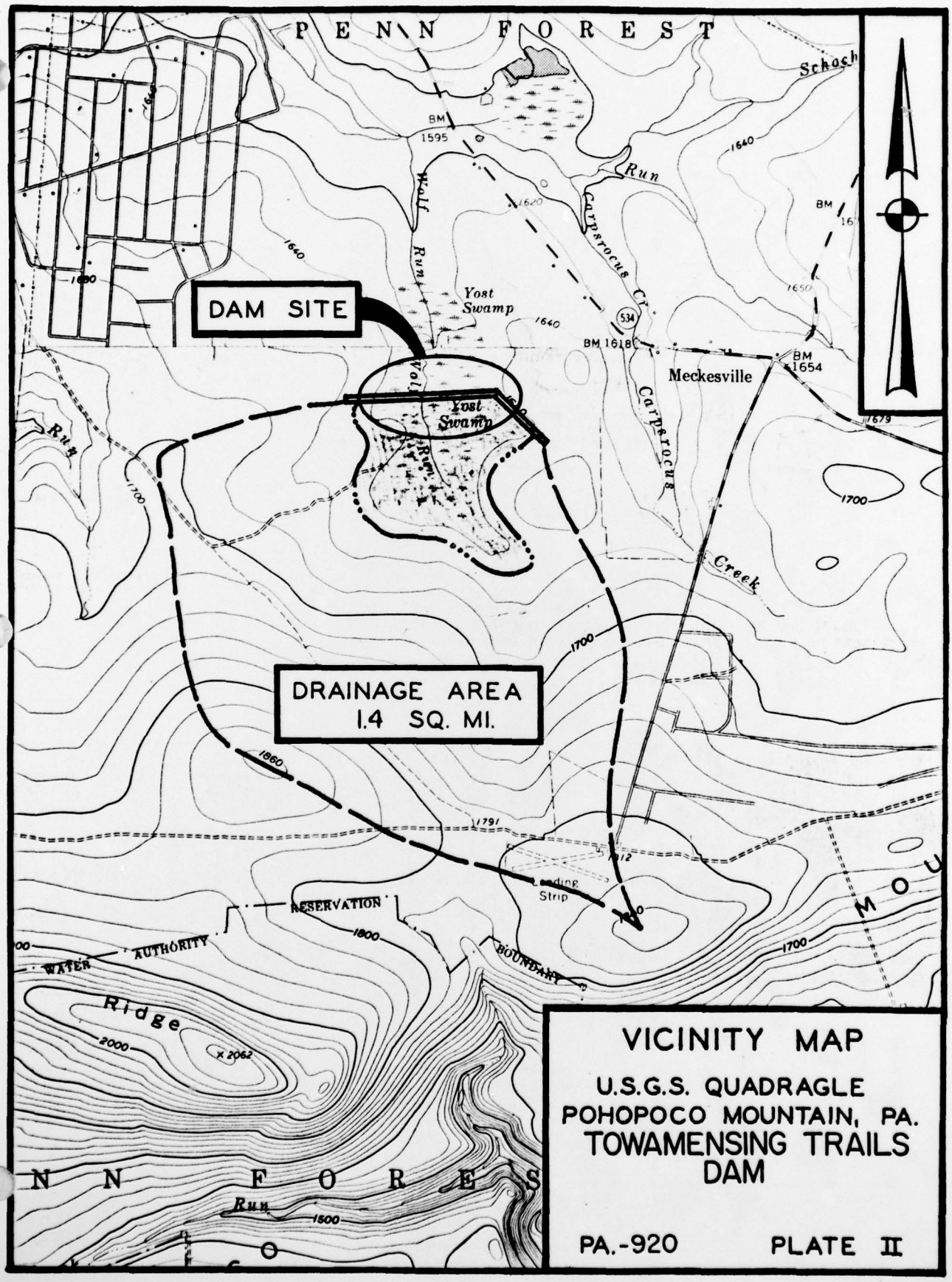
PLATES



LOCATION PLAN

TOWAMENSING TRAILS DAM

PA.-920 PLATE I

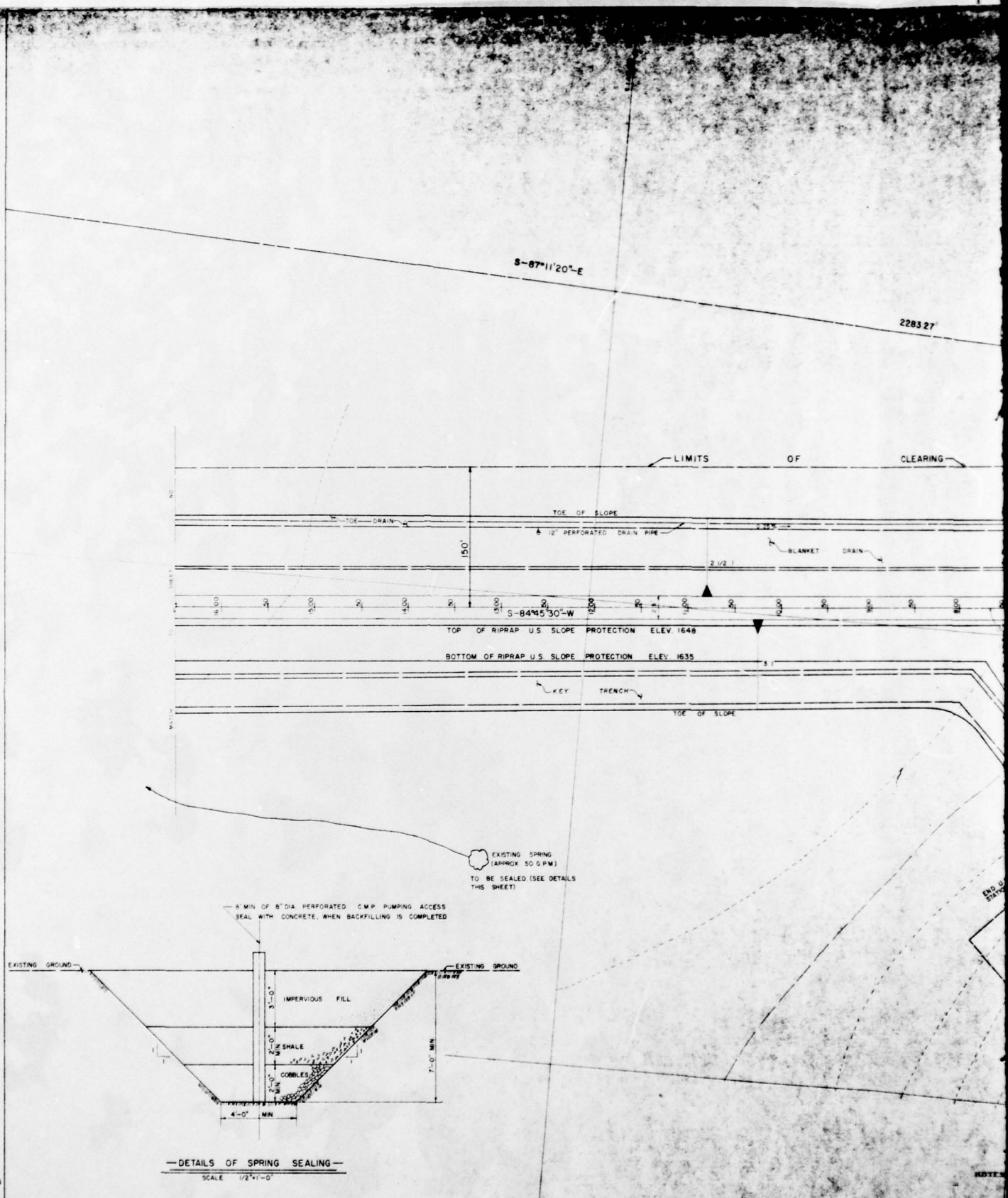


VICINITY MAP

U.S.G.S. QUADRAGLE
POHOPOCO MOUNTAIN, PA.

TOWAMENSING TRAILS DAM

PA.-920 PLATE II



—DETAILS OF SPRING SEALING—

SCALE 1/2"=1'-0"

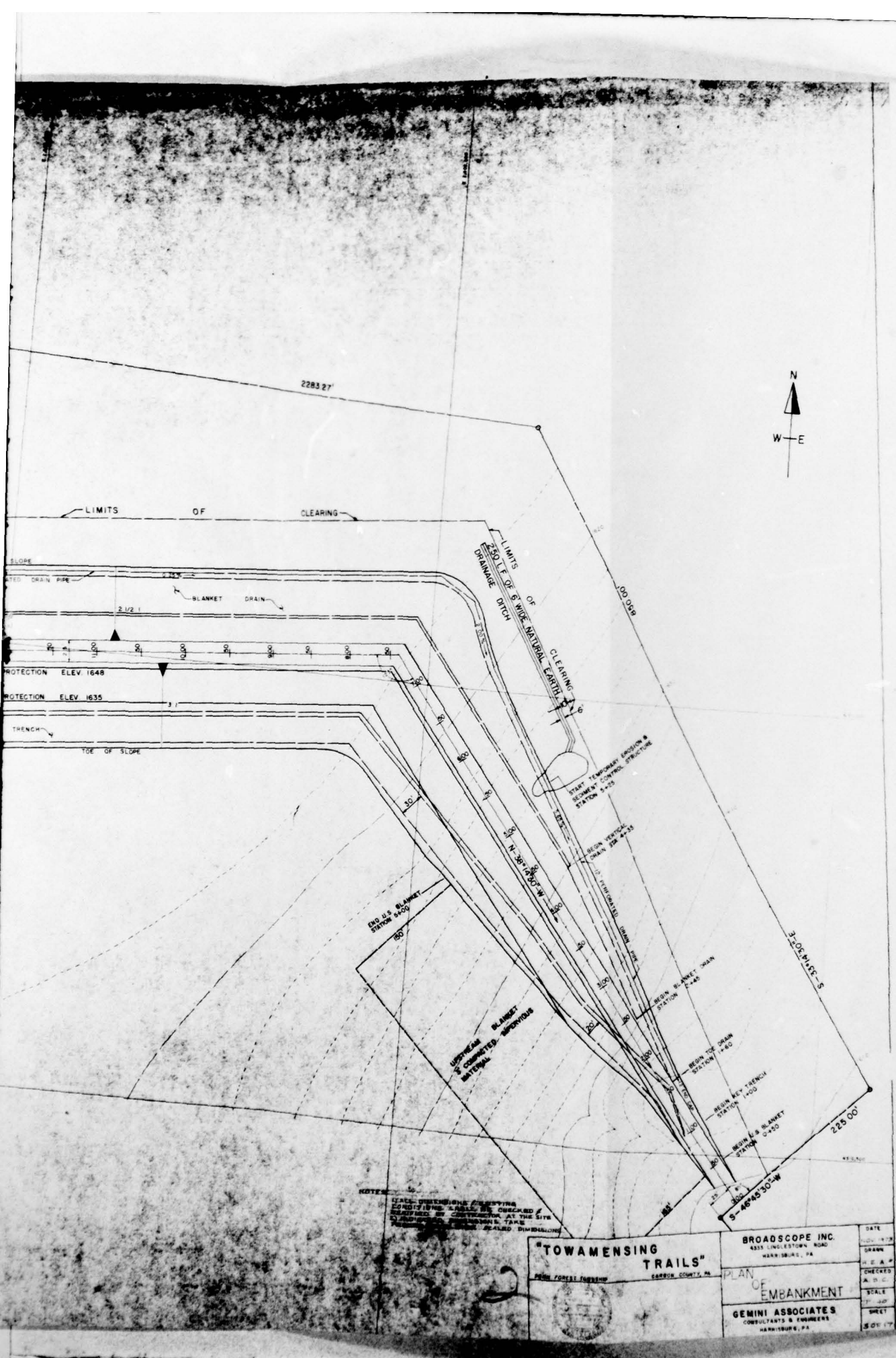
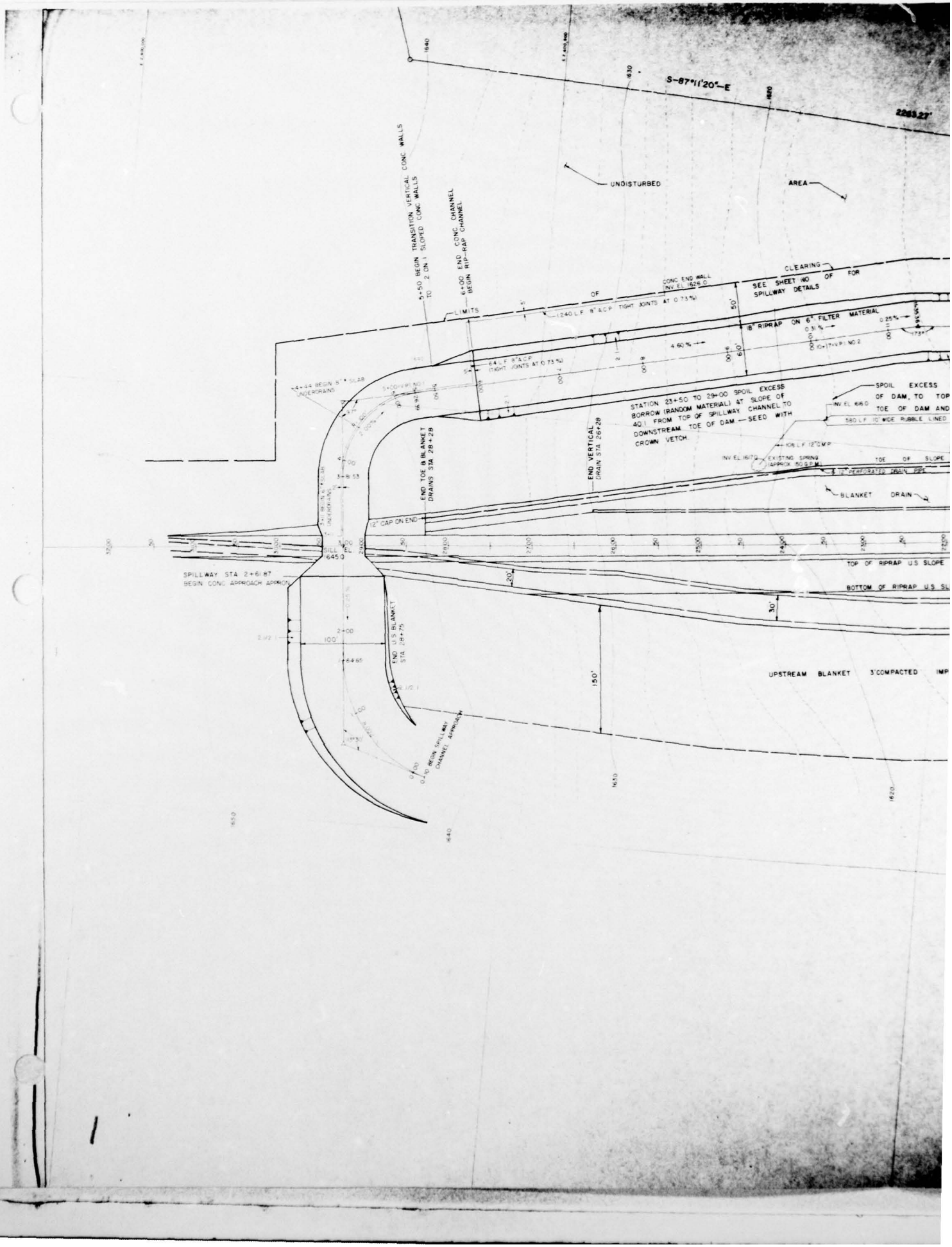
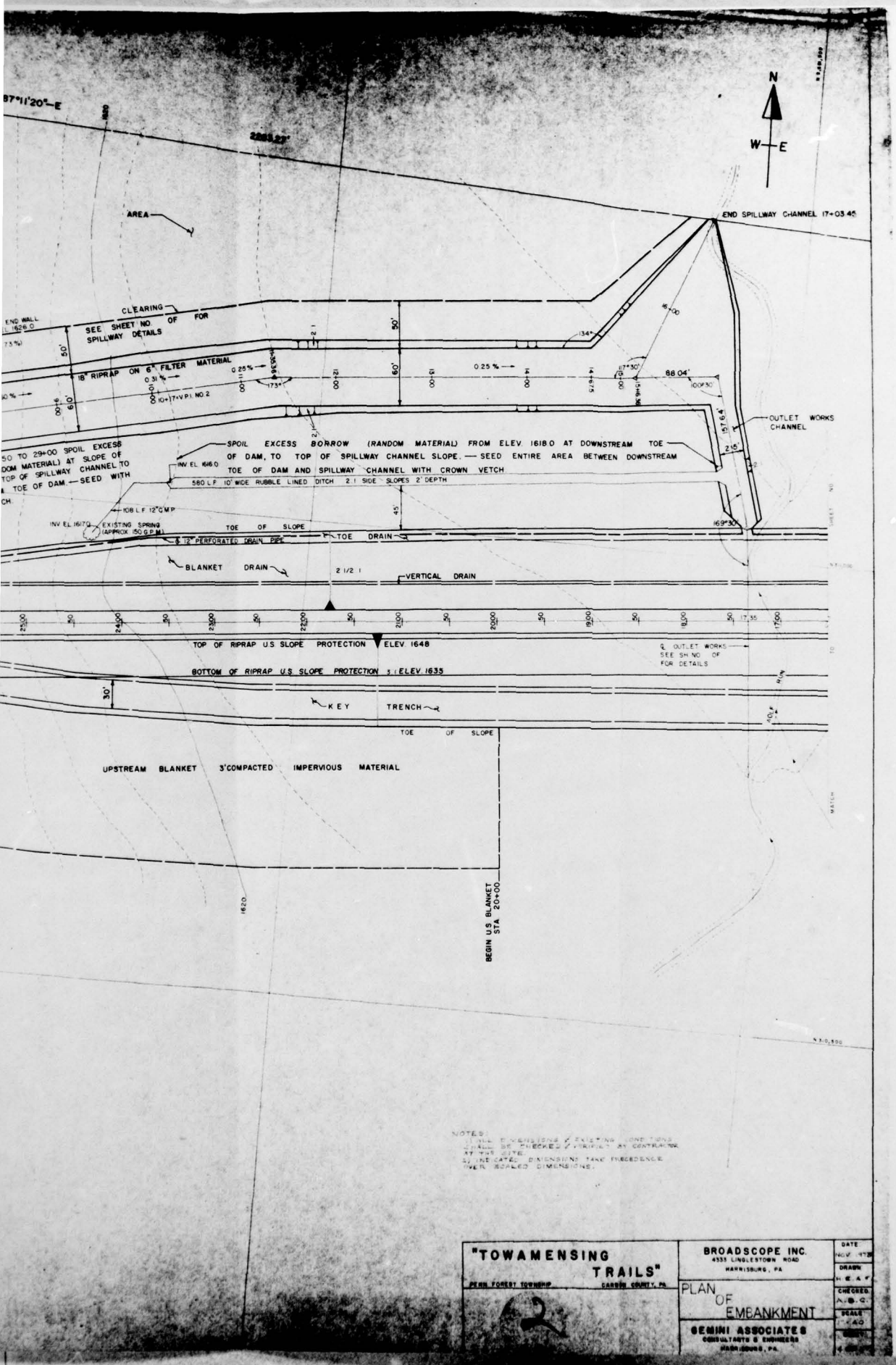


PLATE III PA.-920

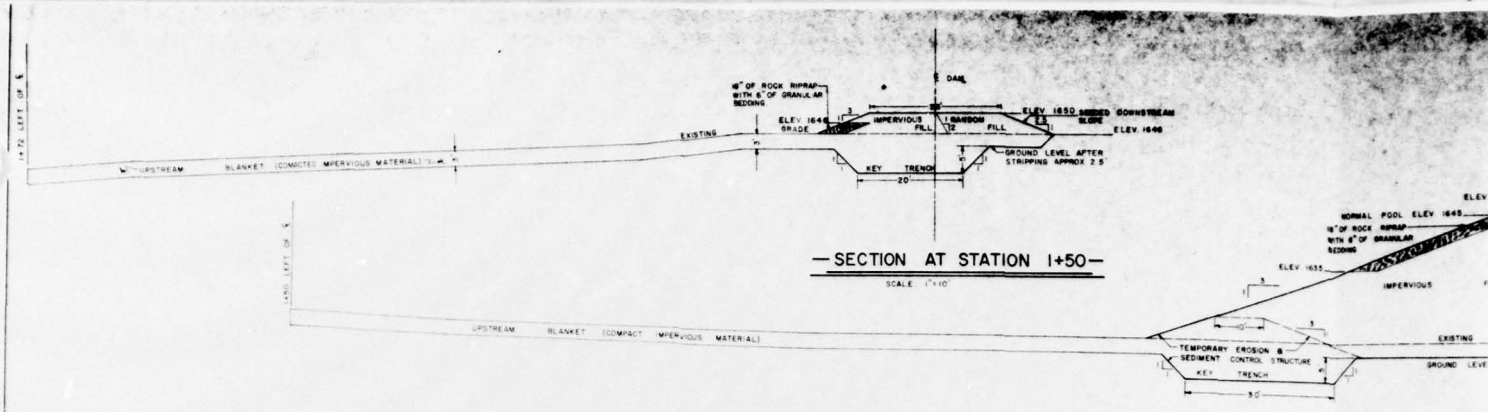

S-87°11'20"-E
2283.27'
UNDISTURBED
AREA
5+50 BEGIN TRANSITION VERTICAL CONC WALLS TO 2 ON 1 SLOPED CONC WALLS
6+00 END CONC CHANNEL BEGIN RIP-RAP CHANNEL
CLEARING
LIMITS
CONC END WALL INV EL 1626.0
SEE SHEET NO OF FOR SPILLWAY DETAILS
1240 L.F. 8' A.C.P. TIGHT JOINTS AT 0.73%
18" RIPRAP ON 6" FILTER MATERIAL
64 L.F. 8' A.C.P. (TIGHT JOINTS AT 0.73%)
4.60%
0.51%
0.25%
4+44 BEGIN 8" SLAB UNDERDRAINS
STATION 23+50 TO 29+00 SPOIL EXCESS BORROW (RANDOM MATERIAL) AT SLOPE OF 4:0:1 FROM TOP OF SPILLWAY CHANNEL TO DOWNSTREAM TOE OF DAM — SEED WITH CROWN VETCH.
SPOIL EXCESS OF DAM, TO TOP
TOE OF DAM AND
580 L.F. 10' WIDE RUBBLE LINED
106 L.F. 12" C.M.P.
INV EL 1617.0
EXISTING SPRING APPROX 50 G.P.M.
TOE OF SLOPE
6" 12" PERFORATED DRAIN PIPE
BLANKET DRAIN
END TOE & BLANKET DRAINS STA 28+28
END VERTICAL DRAIN STA 26+28
12" GAP ON END
TOP OF RIPRAP U.S SLOPE
BOTTOM OF RIPRAP U.S SL
SPILLWAY STA 2+61.87
BEGIN CONC APPROACH APPROA
END U.S BLANKET STA 28+75
UPSTREAM BLANKET 3' COMPACTED IMP
BEGIN SPILLWAY CHANNEL APPROACH



NOTES:
1) ALL DIMENSIONS & EXISTING CONDITIONS SHALL BE CHECKED & VERIFIED BY CONTRACTOR AT THE SITE.
2) INDICATED DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.

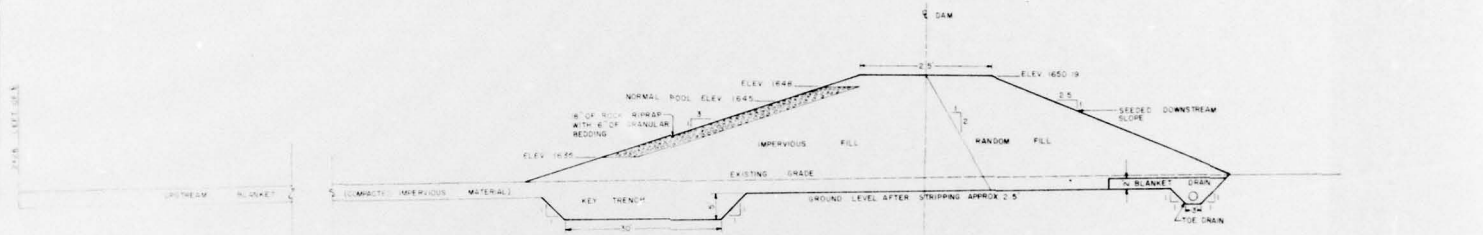
"TOWAMENSING TRAILS" PENN FOREST TOWNSHIP CARBON COUNTY, PA.	BROADSCOPE INC. 4535 LINGLESTOWN ROAD HARRISBURG, PA	DATE NOV. 1972
	PLAN OF EMBANKMENT	DRAWN H.E.A.F.
		CHECKED A.B.C.
	GEMINI ASSOCIATES CONSULTANTS & ENGINEERS HARRISBURG, PA.	SCALE 1"=40'

PLATE IV PA.-920



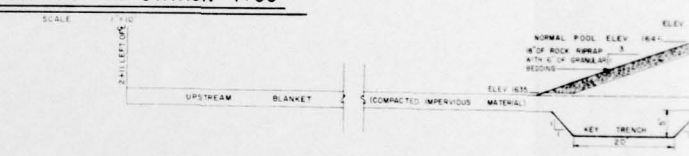
—SECTION AT STATION 1+50—

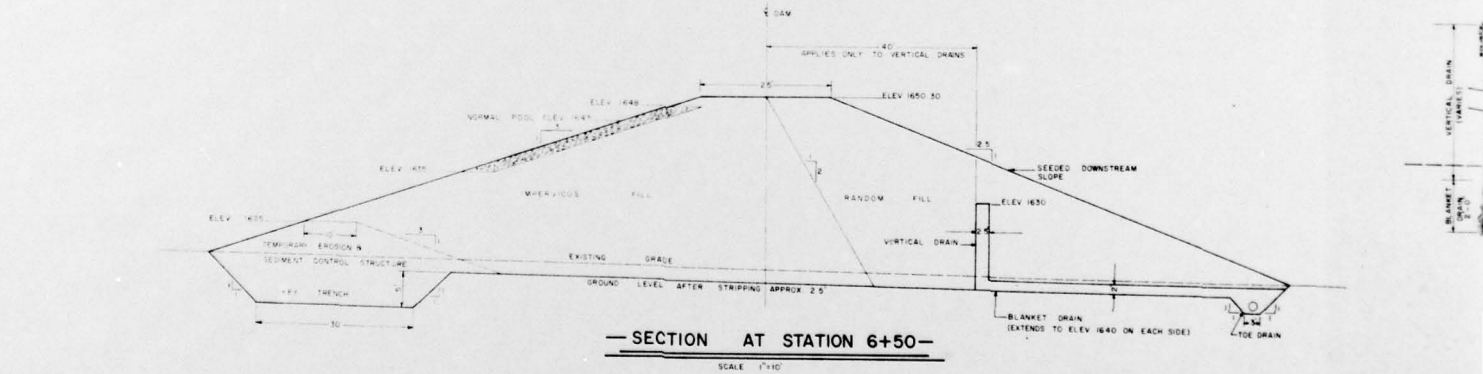
SCALE 1"=10'



—SECTION AT STATION 4+00—

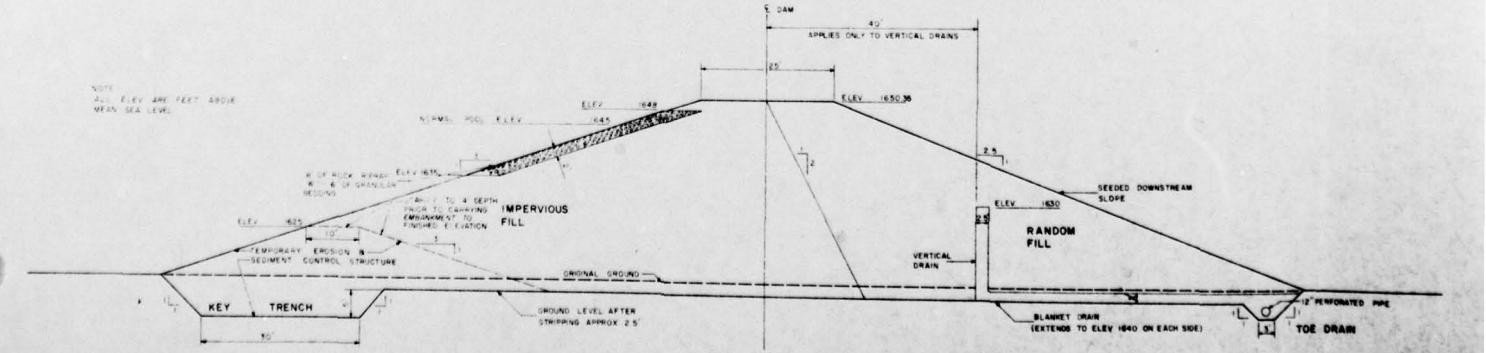
SCALE 1"=10'





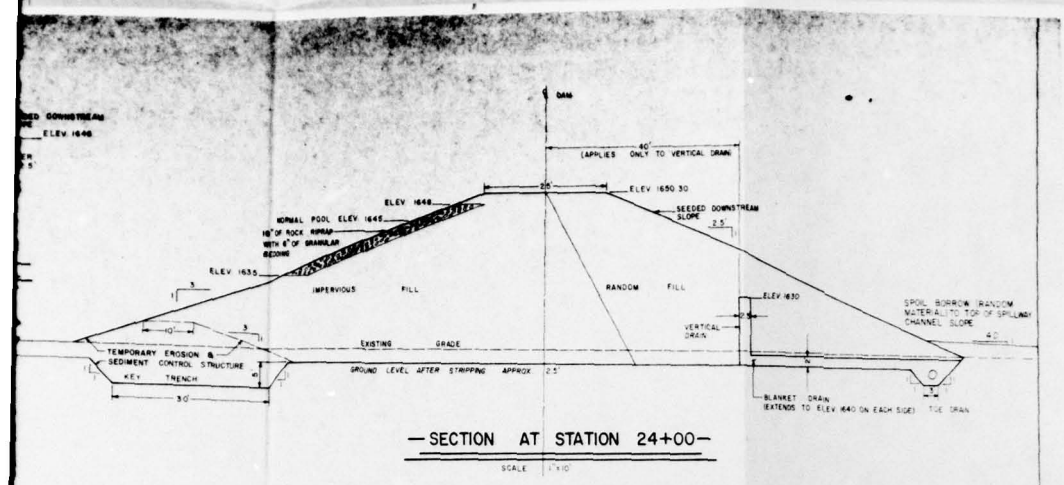
—SECTION AT STATION 6+50—

SCALE 1"=10'



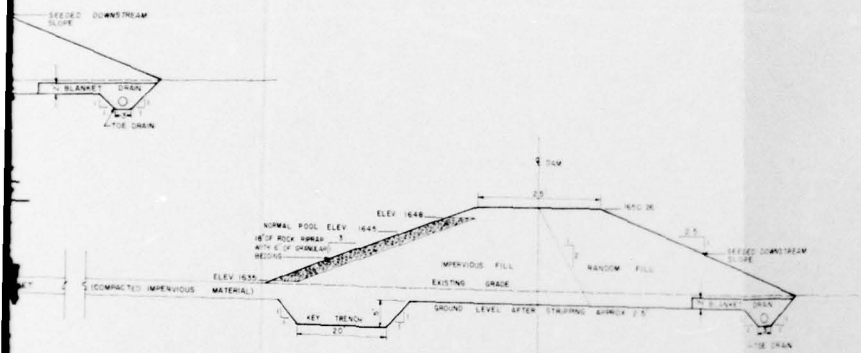
—MAXIMUM SECTION AT STATION 17+00—

SCALE 1"=10'

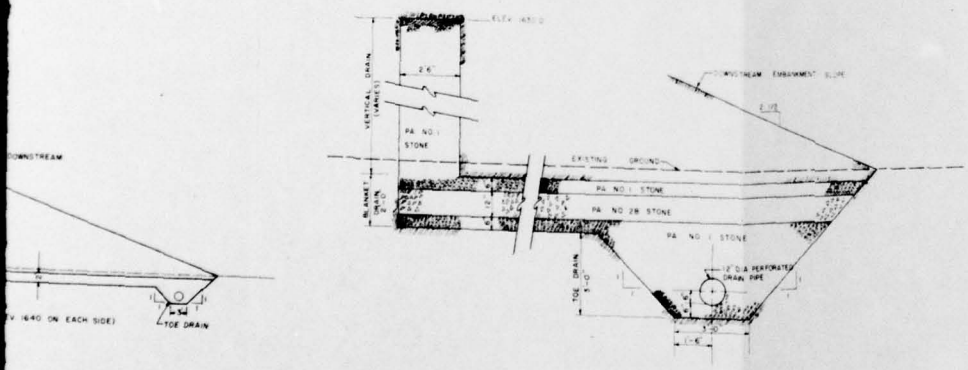


— SECTION AT STATION 24+00 —

SCALE 1"=10'

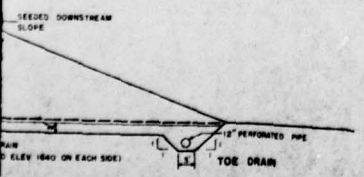


SECTION AT STATION 27+00



— TYPICAL SECTION FOR INTERNAL DRAINAGE SYSTEM —

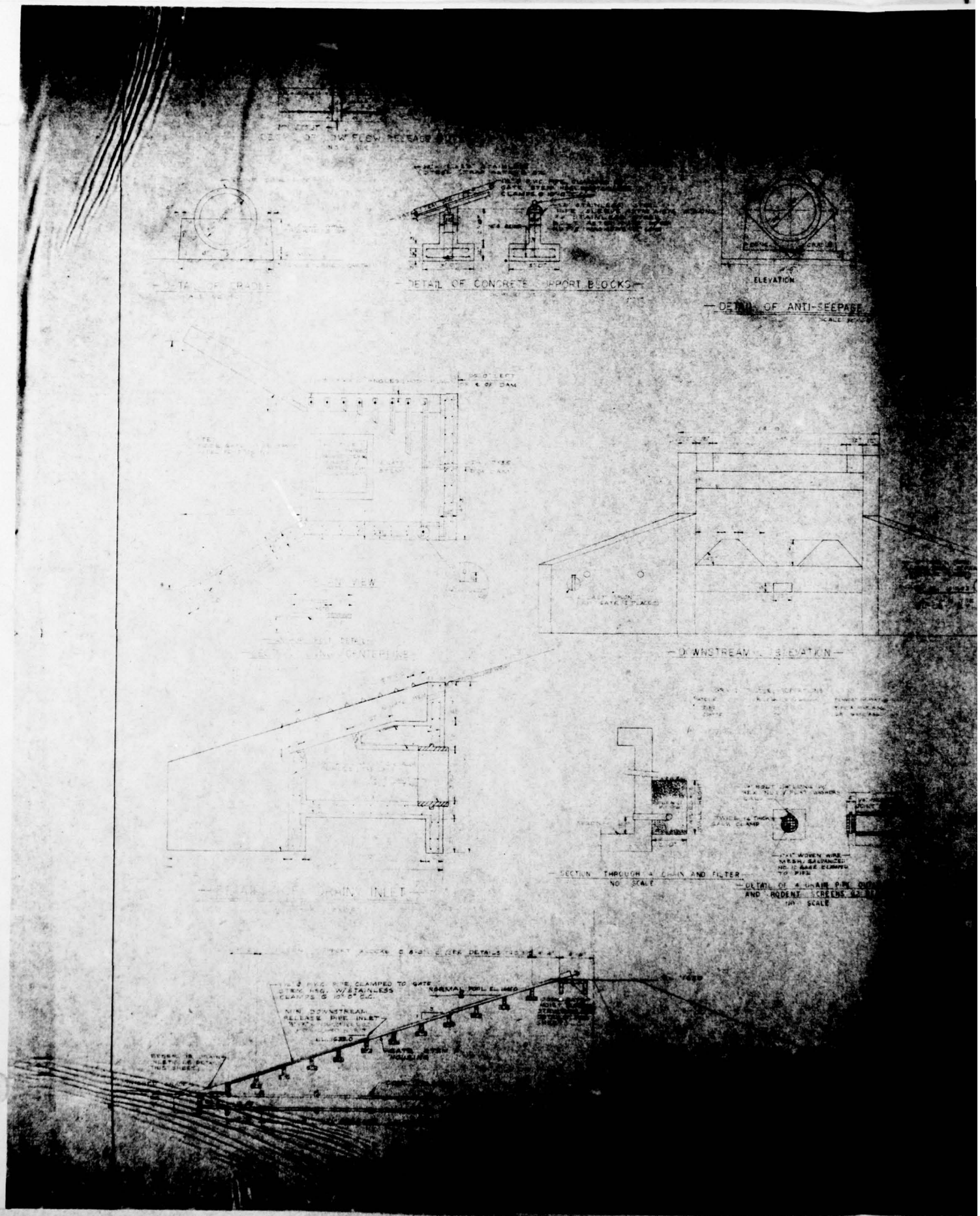
SCALE 1/2"=1'-0"

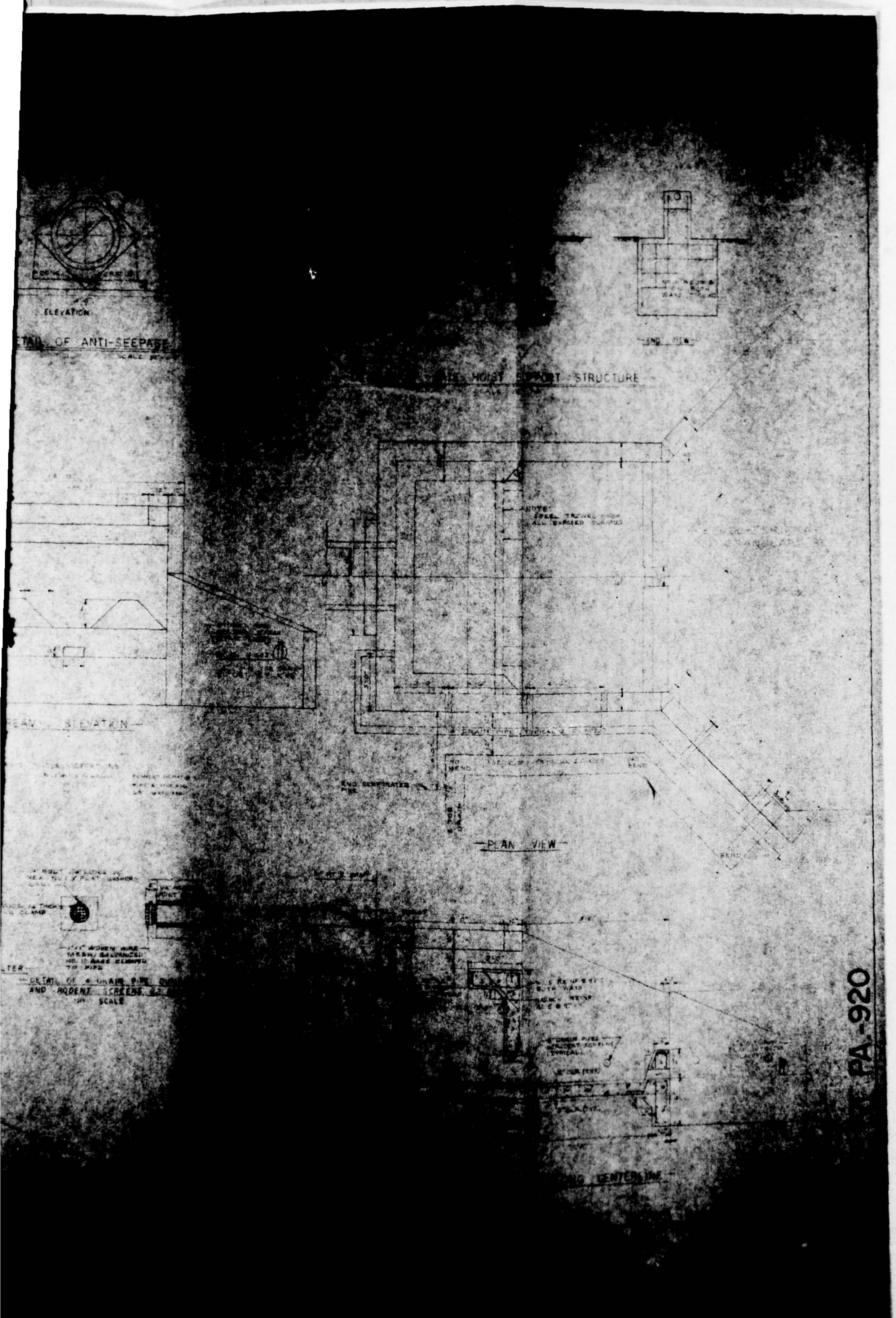


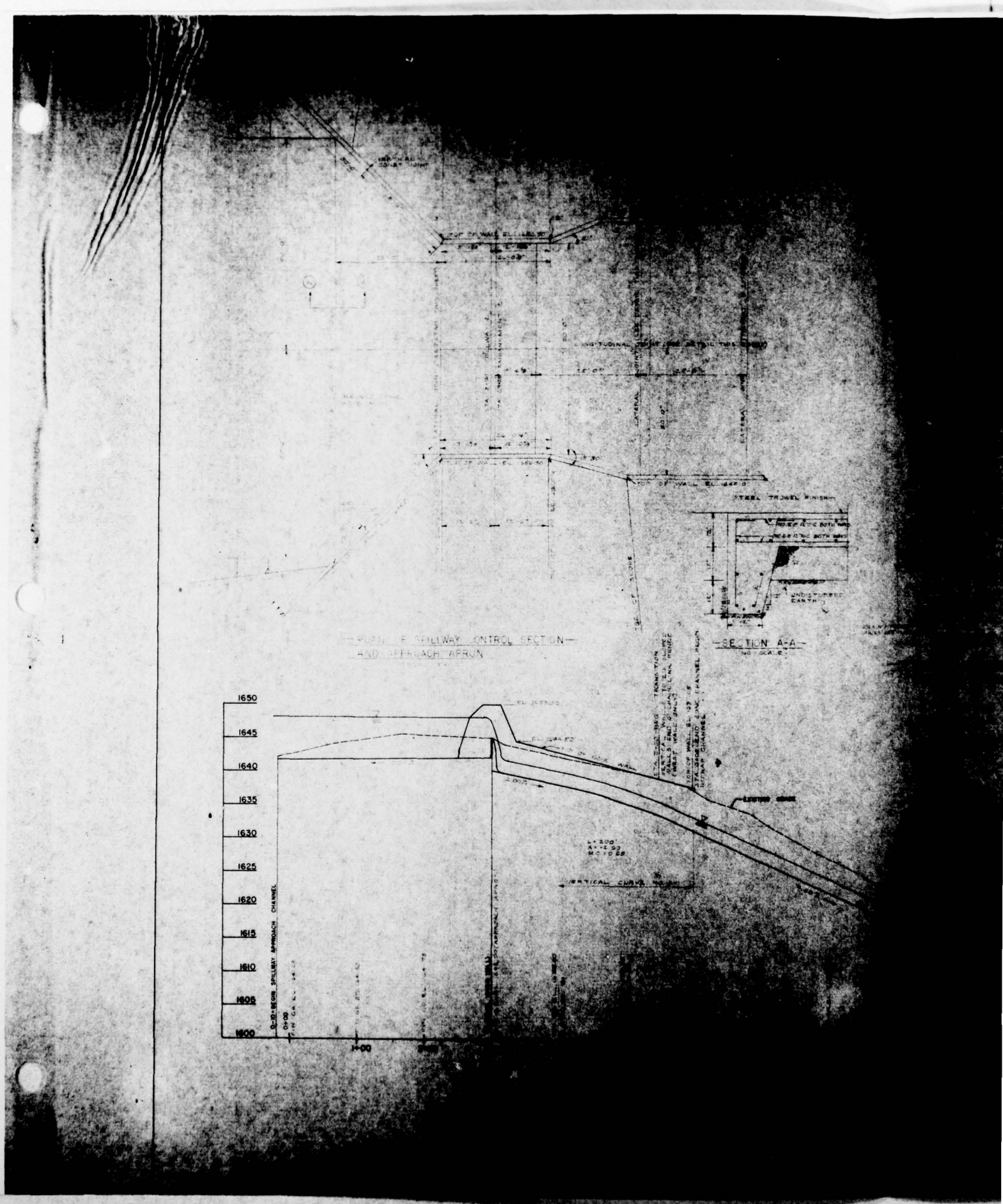
NOTES:

"TOWAMENSING TRAILS" PENN FOREST TOWNSHIP CARBON COUNTY, PA	BROADSCOPE INC. 4333 LINGLESTOWN ROAD HARRISBURG, PA	DATE
		DRAWN
	SECTIONS	CHECKED
		SCALE
	GEMINI ASSOCIATES CONSULTANTS & ENGINEERS	SHEET

PLATE V PA.-920

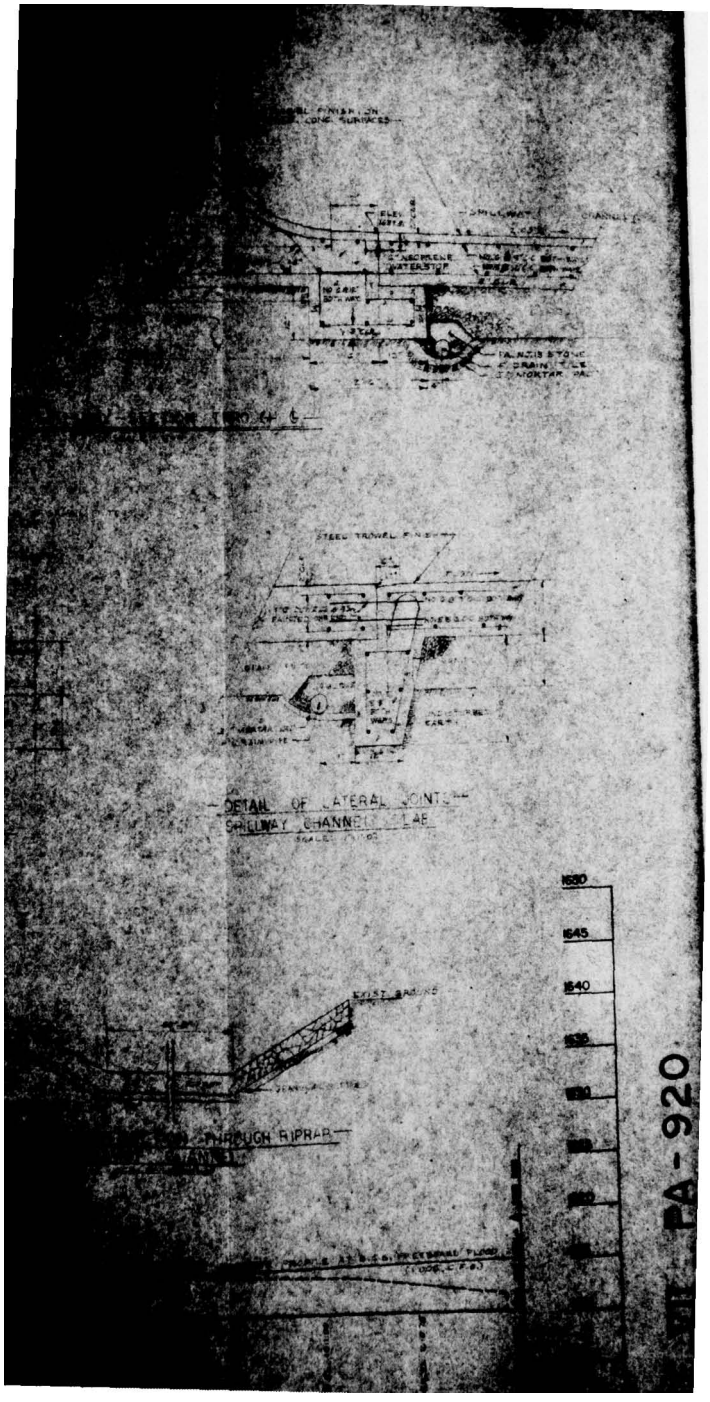

DETAIL OF CONCRETE
ELEVATION
DETAIL OF ANTI-SEEPAGE
SECTION THROUGH
NO SCALE
DETAIL OF
AND RODENT SCREENS
SCALE
MIN. DOWNSTREAM
RELEASE PIPE INLET


ELEVATION
HOIST SUPPORT STRUCTURE
END VIEW
PLAN VIEW
PA-920

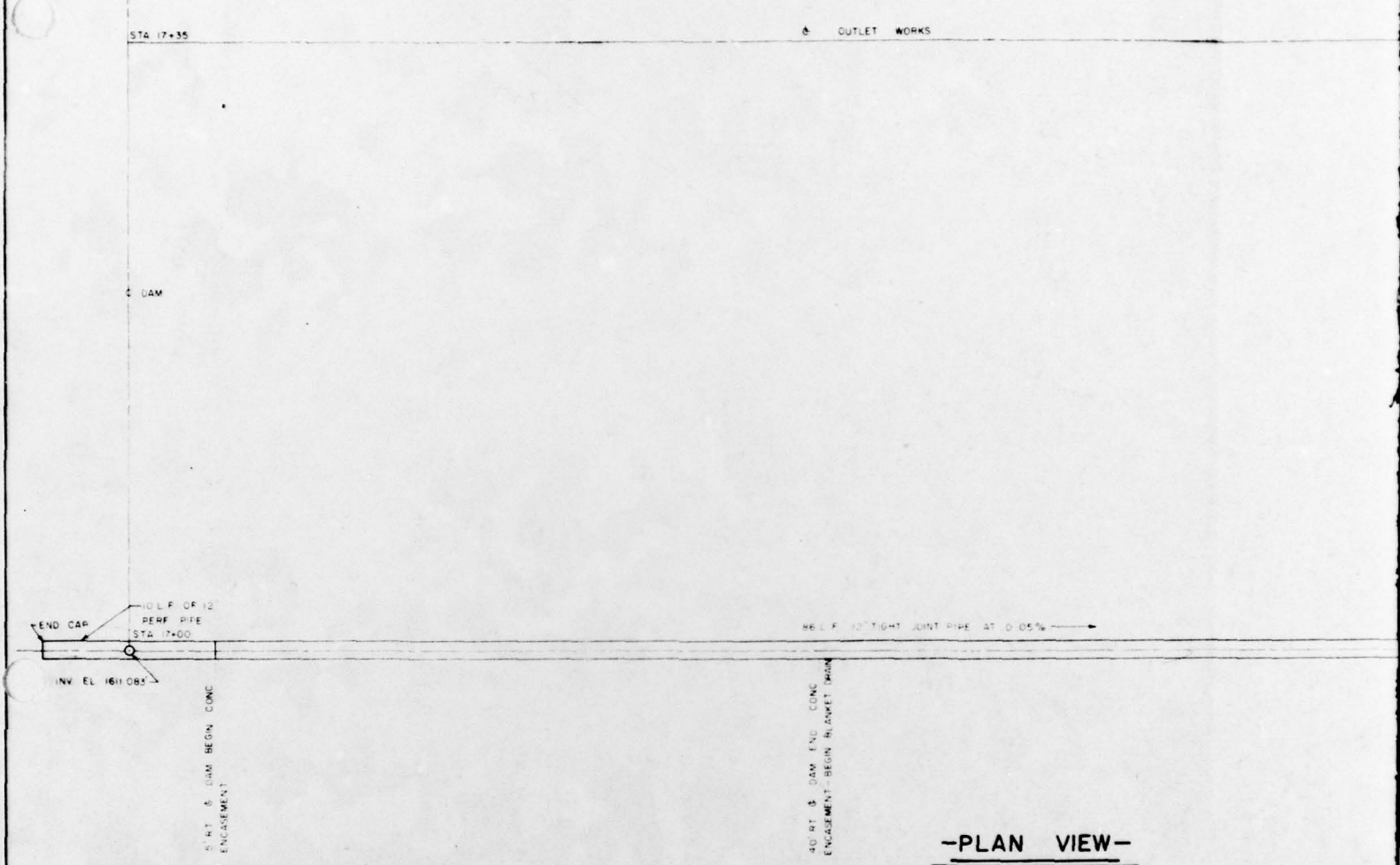


—PLAN OF SPILLWAY CONTROL SECTION—
AND APPROACH APRON

—SECTION A-A—
NO SCALE

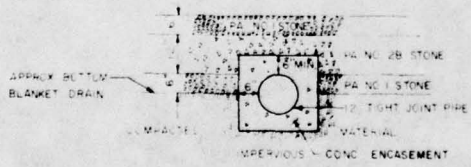


PA-920



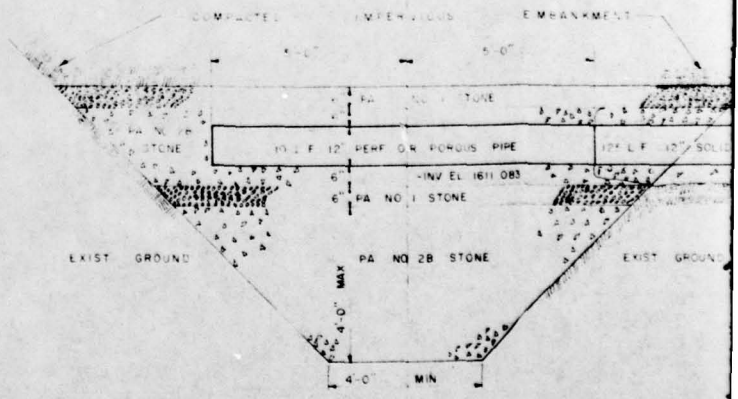
-PLAN VIEW-

SCALE 1/4"=1'-0"



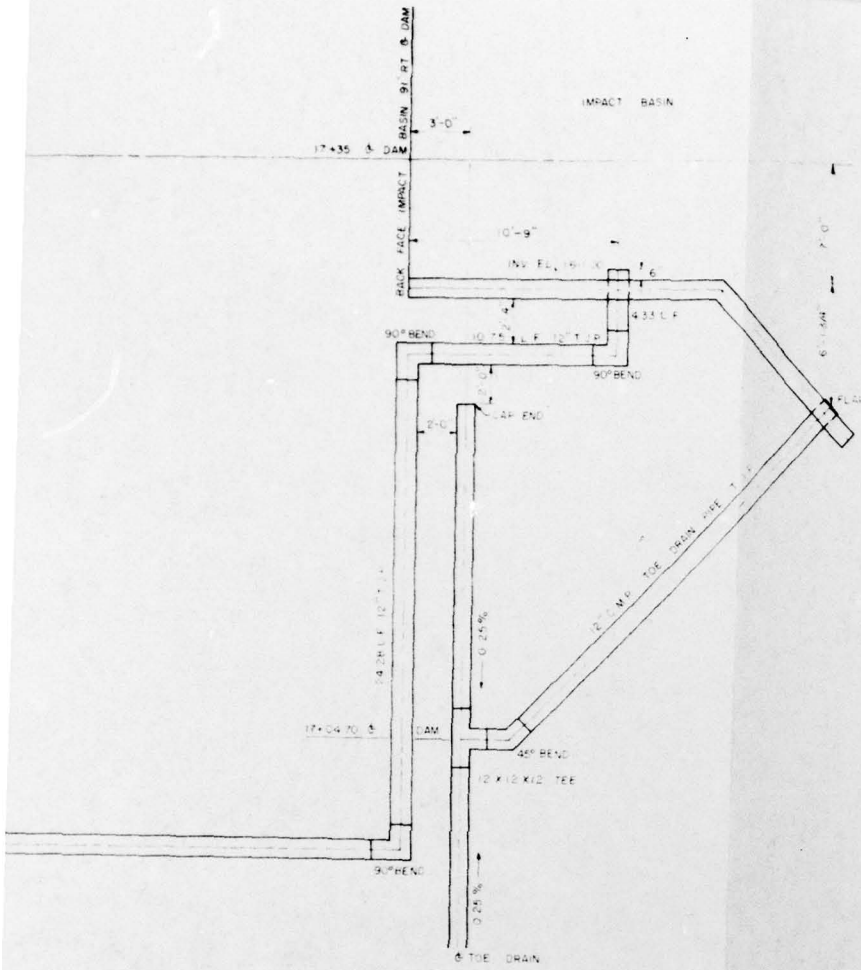
-SECTION THRU CONC ENCASEMENT-

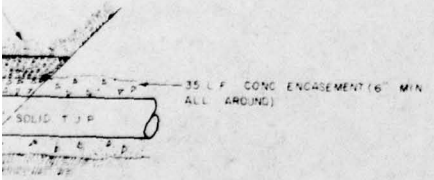
SCALE 1/2"=1'-0"



-SECTION THUR DRAIN-

SCALE 1/2"=1'-0"





BROADSCOPE INC. 4444 INGLETOWN ROAD HARRISBURG, PA	DATE 7-22-74
FOUNDATION DRAIN FOR ARTESIAN FLOW AT 17+00	DRAWN BY H E A[illegible]
GEMINI ASSOCIATES CONSULTANTS AND ENGINEERS HARRISBURG, PA	CHECKED BY A B C
	SCALE AS SHOWN

2

PA.-920
PLATE VIII